Knowledge.

With which is incorporated Hardwicke's Science Gossip and the Illustrated Scientific News.

A Monthly Record of Science.

Conducted by Wilfred Mark Webb, F.L.S., and E. S. Grew, M.A.

JUNE, 1910.

EDITORIAL.

The Editors much appreciate the many kind remarks which have been made with regard to the May number of the Magazine. They are also grateful to those who, though they did not receive their copies until well into the month, kindly forbore to criticise. We may add that the delay was entirely in connection with the publication of the paper and not with its distribution.

Before going on to speak of contributors it is unfortunately necessary for us to contradict a report which is current that certain members of the Optical Trade are financially interested in KNOWLEDGE. There is not the slightest foundation whatsoever for it. No one engaged in the particular sphere of usefulness suggested owns a single share in Knowledge Publishing Company, Limited, and we cannot understand what good or harm the original fabricator of the statement thought that he was going to do when he made it.

Our Geological column has been kindly undertaken by Mr. G. W. Tyrrell, A.R.C.S., F.G.S., who is Professor J. W. Gregory's Assistant in the Geological Department of the University of Glasgow.

To the list of contributors in Physics we are glad to add the names of Professor J. A. Fleming, M.A., D.Sc., F.R.S., Pender Professor of Electrical Engineering (University of London), and Mr. W. D. Eggar, M.A., Assistant (Science) Master at Eton College. We have received promises of help in the future from many well-known workers in science, including:—Mr. George Abbott, M.R.C.S., Founder of the South-Eastern Union of Scientific Societies; Mr. Edward J. Bedford, author of "Nature Photography for Beginners"; Mr. Frederick J. Chittenden, F.L.S., Director of the Royal Horticultural Society's Laboratory at Wisley; Mr. Frederick Enock, F.L.S., F.R.M.S.; Miss Kate M. Hall, F.L.S., Ex-Curator of Stepney Borough Museum; Mr. E. E. Lowe, F.L.S., Curator of Leicester Museum and Honorary Secretary of the Museums Association; Principal Lloyd Morgan, LL.D., F.R.S., University College, Bristol; Mr. Frank Percy Smith; and Professor F. E. Weiss, D.Sc., F.L.S., of the Victoria University.

In the present number Mr. F. A. Bellamy completes his account of Edmund Halley. Some very suggestive remarks with regard to "Heredity and the House of Lords" are made by Mr. David Heron which would form the basis for an interesting discussion. Mr. E. W. Swanton touches on a subject of very general interest in his first contribution on British Galls. One or two of the contributors invoke the aid of our readers in several directions. We ourselves should be very glad indeed to receive notes, photographs, and suggestions for articles. Correspondents are asked kindly to indicate when writing whether they expect payment for their contributions. Even if our readers be not themselves able to write the particular articles that they may have in mind, we should be glad to hear from them.

XUM

NOTES ON BRITISH GALLS.

By E. W. SWANTON.

Curator of Sir Jonathan Hutchinson's Educational Museum, Haslemere.

I PROPOSE to give, under the above heading, occasional notes and illustrations concerning new, or rare, and interesting British galls.

Gall-structures are of special interest, not only to the botanist, to whom, in the words of Anton Kerner, "they show most distinctly how fundamental deviations from the original plan of construction may occur in the adult condition of a portion of a plant," but also to the entomologist, because the life cycle of so many of the insects which, by their attacks upon growing plant tissue, initiate these remarkable hypertrophies, still remains unknown.

The study of galls—cecidology (kekidology) it may be conveniently termed—has been greatly stimulated in this country, in recent years, by the late Mr. Edward Connold's profusely-illustrated books. The early death of this zealous naturalist is deeply deplored by his numerous friends and correspondents.

Mr. Connold was an expert photographer, and his photographs of plants and galls will long remain unrivalled. Particularly fine examples of his work may be seen in "British Oak Galls" published by Messrs. Adlard and Son in 1908.

From a photograph by the late Edward Connold, F.Z.S.

FIGURE 1.

Convolvulus arvensis (the common Bindweed) galled by *Eriophyes Convolvuli* Nalepa.

The illustrations which accompany the present notes are from photographs which he sent me from time to time. Two of them are new British records, which have not, to my knowledge, as yet been published; the others are very inadequately represented in his "Plant Galls," one of them without a name.

Figure 2 shows the common Yarrow (*Achillea millefolium*) galled by the dipteron RHOPALOMYIA MILLEFOLII H. Löw (= *Hormomyia millefolii* F. Löw). Mr. S. L. Mosley found it many years ago at Lepton, near Huddersfield, but did not rear the flies. It is apparently very rare. The specimens here depicted were found by Miss Truda Hutchinson, at Inval, Haslemere, in September, 1907. It has since been noticed every year in the same locality. In May of this year I succeeded in obtaining, from a gall of last season, the beautiful little metallic-green fly. The galls are sometimes bright red in their early stages, and occasionally occur in much larger masses than here shewn.

Figure 1 depicts the common Bindweed (*Convolvulus arvensis*) with the very distinctive gall made by the mite ERIOPHYES CONVOLVULI Nalepa, a new British record. I found it in abundance in June, 1909, on the grassy slopes facing the sea beyond the second fort on Berry Head, Brixham, South Devon. Attacked plants are much stunted, The mid-rib of the leaf is greatly hypertrophied on the upper surface. The swelling is brightly coloured, red or pinkish, with a felt-like covering. This gall must be carefully distinguished from that caused by *Phyllocoptes convolvuli* Nalepa, an allied species, which differs in its yellowish-green tint and the absence of abnormal pilosity.

Figure 4 shews leaves of the Wych Elm (*Ulmus glabra*) galled by the dipteron OLIGOTROPHUS LEEMEI Kieffer. First British record, from specimens sent to Mr. Connold from Worksop in July, 1909. These curious little galls resemble a miniature flagon with the neck and circular opening on one side of the leaf, the swollen base on the other. Each gall contains a single yellow larva. Pupation takes place on the earth, and the imago appears about the middle of the following April. At A is shewn a cluster of leaves so badly attacked as to be atrophied and much distorted; at B, galls on the upper surface of a leaf; and at C, numerous galls in their characteristic position, on, and closely adjacent to, the midrib on the posterior surface.

Figure 3 shews leaves of the Mealy Guelder rose (*Viburnum Lantana*), with galls caused by OLIGOTROPHUS SOLMSII Kieffer. This photograph was reproduced in part (and poorly) in British "Plant Galls" without a name. The leaves are part of a gathering which I obtained on the chalk downs near

Maidstone in June, 1904. The galls are very distinctive. The pustules on the upper surface are glabrous; red or purple with green centre in fresh specimens, becoming entirely purple if kept in a

From a photograph by *the late Edward Connold, F.Z.S.*

FIGURE 2.

Achillea millefolium (Yarrow) galled by *Rhopalomyia millefolii* H. Löw.

vasculum for a day or two. The corresponding under surface is whitish, sometimes slightly projecting, sometimes depressed, always pubescent.

In his "Plant Galls of Great Britain" published early last year by Messrs. Adlard & Son, Mr. Connold depicted several galls, the causes of which were unknown to him. The following notes upon some of these, also other galls enumerated therein, may be of interest to readers who possess a copy of that book. In all cases the number refers to the gall, not to the page.

23. Shews leaves of *Populus tremula* galled by a mite, ERIOPHYES DISPAR Nalepa. Easily known by the revolute and thickened leaf margins.

24. Leaf of *Populus tremula* with galls caused by HARMANDIA TREMULAE Wtz, a dipteron. It also occurs on *Populus alba*.

47. This is certainly the gall of the dipteron MASSALONGIA RUBRA VERRU Kieffer, on leaf of *Betula alba*. It may also be found on *B. pubescens (= remicosa)*.

48. A leaf of *Betula alba* with an unusual aggregation of galls caused by the dipteron CONTARINIA BETULINA Kieffer. It also attacks *B. pubescens*.

78. The gall-wasp responsible for this rare gall on *Centaurea scabiosa* is known on the Continent as AULAX FITCHI Kieffer.

83. The gall caused by the dipteron PERRISIA LOTHARINGIAE Kieffer, is here described. This fly attacks several species of *Cerastium*.

87. Shews the characteristic gall of the hemipteron TRIOZA CENTRANTHI Vallot, on *Valerianella dentata*. On the Continent this insect attacks various species of *Valerianella*, *Fedia*, and *Centranthus*.

106. This gall was brought to me ten years ago. From my notes I gather it was probably made by a dipteron, but I failed to rear the flies. I allude to it here in the hope that it may be again observed. I should value living specimens of the Adder's Tongue with this gall. The plant being so small it can be easily dug up without disturbing the root.

108. The gall here depicted is certainly that of CHERMES (ADELGES) STROBILOBIUS Kalt, not *C. Abietis*, Kalt, as stated. The gall of the latter is much larger, and is well shewn under 110.

From a photograph by *the late Edward Connold, F.Z.S.*

FIGURE 3.

Viburnum lantana (Mealy Guelder-rose) galled by *Oligotrophus solmsii* Kieffer.

112. Shews the stem of *Ulex minor* Roth *(= nanus* Forster*)* galled by the beetle APION SCUTELLARE Kirby.

116. The author was inerror in attributing this gall to *Asphondylia genistae* H. Löw. The gall which results from the attack of this cecid is situated in the axil of the leaf, and consists of a single closed cavity, the home of a single larva. The gall which he figured and described is caused by the dipteron PERRISIA GENISTICOLA F. Löw. It is also figured in Houard's "Zoocécidies des plantes d'Europe," fig. 838.

128. The cause of this gall on *Corylus avellana* is at present not definitely known. Connold figured what appears to be the same specimen in "British Vegetable Galls," and therein attributes the distortion to the attacks of a mite *Eriophyes avellanae* Nalepa. Many "witches' brooms" may arise through either insect or fungal agency; *e.g.*, those so commonly seen on the birch are, in Scotland, caused by the fungus *Exoascus turgidus*, in the Midland Counties by a mite.

135. I do not think there is ever any hypertrophy in connection with the fungus *Tremella mesenterica*, frequently seen in late winter on decaying branches. It is a saprophyte, not a parasite. Connold probably found a sporophore growing from a branch, a part of which had been cankered and killed by something else.

140. The midribs of leaves of *Centaurea nigra* here shown were probably attacked by the larvae of a dipteron, LOEWIOLA CENTAUREAE F. Löw. This gall is very distinctive in the violet or yellowish border. Connold described his specimens as multilarval; the gall of *L. centaureae* is, however, unilocular.

150. Shews leaf petiole of *Acer campestre* with gall caused by the dipteron ATRICHOSEMA ACERIS Kieffer.

153. This is, in all probability, the gall of the mite, TARSONEMUS SPIRIFEX Marchal. The curious loop is very characteristic.

224. Shows cupules of *Quercus Ilex*, galled by CYNIPS KIEFFERI Cabrera. It is also figured in "British Oak Galls." These galls were sent to Connold from the Chadwick Museum, Bolton, in 1902, with a label stating that they were taken in the Isle of Wight.

From a photograph by the late Edward Connold, F.Z.S.

FIGURE 4.

Ulmus glabra (Wych Elm) galled by *Oligotrophus Leemei* Kieffer.

263. Shews the characteristic tassel-like gall of the hemipteron, LIVIA JUNCORUM Lat.; which occurs on various rushes. The figure is unfortunately upside down. For a splendid photograph of this gall see Plate 103 of "British Vegetable Galls." It is probably widely distributed; I have seen it in Surrey and Devon.

288. Here we have a leaf of *Acer Pseudo-platanus* with numerous galls on the upper surface caused by the mite ERIOPHYES MACROCHELUS Nalepa.

In 1898 I began to prepare an annotated list of British galls, arranged according to the classification adopted in the London Catalogue of British Plants. Ten years later the tenth edition of that well-known catalogue appeared, and necessitated the rearrangement of my list. I hope shortly to publish it in its present form, as an appendix to a little book on British cecidology which I am now preparing. I take this opportunity of asking entomologists and botanists kindly to assist towards making the list of British galls as complete as possible by sending me any remarkable examples that may come under their notice this year.

(Mr. Swanton's Address is—The Educational Museum, Haslemere.—Ed.)

NATURE STUDY.

Everything is to be said in favour of true Nature Study—using the words in their educational sense—that teaches children to observe, and those who are familiar with the movement in its favour in this country, and with the exhibitions that have resulted, will know that there are a few schools where really good observational work is done. These fulfil the exhortation to learn by doing, and one where Nature Study is carried out side by side with many valuable handicrafts (suitable for girls) is the Croft School, which is now located at Fleet, in Hampshire, having been removed from Betley, near Crewe. The Principal, Miss M. L. Hodgson, did much good work at the House of Education, Ambleside (which is in connection with the Parents' National Educational Union), and acted as one of the Judges at the Nature Study Exhibition in 1903.

We are interested to hear that on the 23rd of this month Sir Edward Braybrook will lay the Commemoration Stone in the new buildings of the Croft School, at Fleet, at 3 o'clock in the afternoon.

HEREDITY AND THE HOUSE OF LORDS.

By DAVID HERON, M.A.

THE main grounds which led the Rosebery Select Committee to the opinion that some modification of the composition of the House of Lords was desirable was the conviction that it was necessary that those peers who have no desire for parliamentary work, and those who for various reasons are not considered suitable for that work, should be excluded from the House by some process of selection. Any consideration of the present constitution of the House of Lords will thus naturally deal first of all with the process of selection which has, up to the present, taken place.

The Princes of the Blood Royal will not be considered, but of the others a large number have been directly selected. These include the Scottish and Irish Representative Peers, and all those who are the first to hold their respective titles, and among these we may also include those who have themselves been advanced in rank in the Peerage, as presumably a peer must have shown some conspicuous ability, or have done some special service to be so honoured.

Among those who have been directly selected we may also include the Archbishops and Bishops, since, although not directly selected as members of the House of Lords, they have undergone fairly stringent selection before reaching the Episcopal Bench.

The majority of the peers, however, have not been directly selected; in their case the selection has been indirect, and their position is due to some ancestor who was so honoured.

At the present time few will be found to deny that ability is inherited, and the work of Galton, Pearson, and Schuster has made it certain that the children of the very able are distinctly superior to the children of those who are less gifted. It is also certain that this inheritance extends beyond the first generation, and that the grand-children, great-grand-children, and so on, of the very able have more than average ability, although their superiority becomes less marked as the relationship becomes more remote, a weakening which only takes place owing to the absence of mates of equal ability.

Now the House of Lords consists of a number of individuals, of whom some have been directly selected, while others have been selected through their fathers, grandfathers, or other ancestors; and we can roughly estimate the influence of heredity by finding the *average* relationship between the present peers and those who were originally selected as worthy of this distinction.

It would be a somewhat tedious task to determine the exact degree of relationship in every case, but we can arrive at a fairly accurate measure of that relationship by considering the dates at which the peerages were created, *i.e.*, the dates at which selection took place. In the case of those peers who hold several titles, the date of the most recent has been considered.

Excluding the Bishops and Representative Peers, we find that one hundred and eighty-one peers, out of a total of five hundred and forty-three, have been created during the last thirty years; similarly seventy-seven peerages fall in the period 1850-1880, ninety between 1820 and 1850, and so on. The list extends back to the period 1280-1310, and in the case of five peerages no advance in rank has taken place since that time.

The average date of the creation of those peerages is 1817, and if we include the Bishops and Representative Peers we obtain the year 1819 as the average date of selection.

At this stage we must take into account several factors of which we have no definite measure. In the first place we do not know the exact degree of assortative mating in the peerage, *i.e.*, we do not know how closely husband and wife resemble each other. It is, however, very probable that it is considerably higher than in the general population. Further, in the case of many peers selection has taken place not once but several times. Thus the Marquis of Lansdowne is also Earl Kerry and Shelburne and Lord Nairne; selection may accordingly be said to have operated three times. Both those factors tend to increase the stringency of selection, and to increase the average ability which is to be expected. A third factor acts in the opposite direction, and has an unfavourable influence. It has been shown that the first two members of a family are *slightly* more liable to insanity, tuberculosis, albinism, and criminality than the later-born members.

Taking all those factors into consideration, we shall not go far wrong if we state that *on the average* each peer has a distinguished grandfather, where "distinguished" is used to indicate that form of ability which is rewarded by a peerage.

It is thus clear that the present House of Lords will have nearly the same degree of ability as the *grand-children* of the original peers, and if the original peers had been chosen for conspicuous ability, the present peers would have been distinctly above the average.

It is, however, admitted that peerages have been awarded to those whose ability has been by no means conspicuous, to political failures, and to those whose sole qualification seemed to be the possession as distinct from the acquirement of wealth, but it is probably fair to assume that all those have possessed some kind of ability.

Under the present system, then, the House of Lords is likely to be, somewhat but not markedly, above the average ability; that it is not more distinguished is not the fault of heredity, but of the system of succession and of the standard of mating which really gives heredity so little opportunity.

XUM

MIDSUMMER SHOOTING STARS.

By W. F. DENNING, F.R.A.S.

JUNE is not usually considered a suitable month for observing meteors. The strong twilight, the short nights, and the absence of any special displays, all tend to render the Midsummer season somewhat uninteresting to the meteoric student. June is, in fact, the quiet month providing the lull before the storm of meteors which embellish the skies of July and August.

But though meteors are not so abundant in June as in the Summer and Autumn nights, yet they are highly interesting, and there is no month of the year which can furnish a more genial atmosphere, or more beautifully attractive skies. I have stood in the open, watching meteors in every month of the year, but not one of them is like June.

True meteors are seldom numerous, but those observed are often as interesting in character as they are attractive in appearance. There are fireballs from Scorpio, Sagittarius and other constellations, but these are only occasional. The largest fireballs often come unexpectedly, and frequently in the strong twilight of early evening.

If meteors are rare at Midsummer they give evidence of a great number of feeble streams. These have now been pretty thoroughly investigated, but further watching is desirable to corroborate existing results and furnish evidence of new showers.

In June, 1887, the atmosphere was splendidly clear, and I watched the sky during forty-two hours and saw one hundred and ninety-six meteors. This result will show pretty distinctly the comparative rarity of these objects. The month, however, provides many interesting showers, though I do not know one of very special activity. In one year a radiant may be very active, but in another it is apparently extinct, or nearly so. In fact, consulting the record of many watches in June, it is difficult to select the particular streams entitled to take precedence for their activity.

One point about the meteors of the month named is that they are generally short and streakless. In the four years, 1877, 1885, 1886 and 1887, I found the relative values in June and July as under:—

	Meteors recorded.	With streaks.	Proportion.
June ...	252 ...	31 ...	8·1 to 1
July ...	641 ...	141 ...	4·5 to 1

In June the twilight would assist in obliterating the fainter streaks, and the great prevalence of Perseids in July and August would, perhaps, have the effect of inducing a far larger proportion of streak-leaving meteors in July and August than in June.

Showers in Cepheus and Cyprus are abundant in June. Draco also yields some fairly rich streams at this epoch, and the sky needs further watching with the assured prospect to the observer of securing very interesting materials.

THE FACE OF THE SKY FOR JUNE.

By W. SHACKLETON, F.R.A.S.

THE SUN.—On the 1st the Sun rises at 3.51 and sets at 8.4; on the 30th he rises at 3.48 and sets at 8.18. Summer commences on the 22nd, when the Sun enters the sign of Cancer at 8 a.m.; this is the longest day, the Sun being $16^h\ 34^m$ above the horizon. The equation of time is negligible on the 14th and 15th; hence these are convenient days for adjusting sun-dials, as only the correction for longitude is needed. Sun-spots and prominences continue to be fairly numerous; at the time of writing there is a large spot visible.

Sun-spots may be observed by means of an ordinary deer-stalking or look-out telescope if held sufficiently steady, but it is imperative that a dark glass or a piece of glass heavily smoked be interposed between the eye and the telescope, otherwise there is a great risk of permanently injuring one's eyesight.

The positions of the Sun's axis, equator, and heliographic longitude of the centre of disc are shown in the following table:—

Date	Axis inclined from N. point.	Centre of Disc S. or N. of Sun's Equator.	Heliographic Longitude of Centre of Disc.
June 5 ...	14° 6′W	0° 4′S	187° 22′
,, 15 ...	9° 59′W	1° 8′N	55° 1′
,, 25 ...	5° 34′W	2° 18′N	282° 38′
July 5 ...	1° 1′W	3° 24′N	150° 16′

THE MOON:—

Date.	Phases.	H. M.
June 7 ...	● New Moon.	1 16 p.m.
,, 14 ...	☽ First Quarter.	4 19 p.m.
,, 22 ...	○ Full Moon.	8 12 p.m.
,, 30 ...	☾ Last Quarter.	4 39 a.m.
July 6 ...	● New Moon.	9 20 p.m.

OCCULTATIONS.—The only naked-eye star occulted before midnight is the 3rd magnitude star α Librae. The star is a naked eye "double." The appended diagram illustrates the conditions of occultation; disappearance takes place on June 18th at 10.51 p.m., and reappearance five minutes after midnight.

Occultation of the double star α Librae.

THE PLANETS.—Mercury (June 1st, R.A. $3^h\ 55^m$; Dec. N. 16° 58′; June 30th, R.A. $5^h\ 10^m$; Dec. N. 21° 19′) is practically invisible throughout the month in consequence of the prolonged twilight. The only possibility of observing the planet is for a few days on either side of the 20th, since on that date he is at greatest westerly elongation of 22° 48′, and rises in the N.E. at 2.48 a.m., or 1 hour in advance of the Sun.

Venus (June 1st, R.A. $1^h 46^m$; Dec. N. 8° 35′; June 30th, R.A. $3^h\ 56^m$; Dec. N. 18° 25′) rises about 2 a.m. throughout the month, but for all useful purpose of observation the planet is invisible.

Mars (June 1st, R.A. $7^h\ 23^m$; Dec. N. 23° 24′; June 30, R.A. $8^h\ 39^m$; Dec. N. 19° 43′) appears on the confines of Gemini and Cancer, not far from Castor and Pollux, shining as a reddish star. The planet sets in the N.W. about 10.30 p.m.; his apparent diameter is, however, too small for any useful telescope observations to be made.

Jupiter (June 1st, R.A. $12^h\ 19^m$; Dec. S. 0° 31′; June 30th, R.A. $12^h\ 23^m$; Dec. S. 1° 6′) appears as a brilliant star looking S.W. at sunset. The planet sets about 1.30 a.m. on the 1st and about 11.50 p.m. on the 30th. For small telescopes this is the easiest and most interesting planet to observe, on account of his brightness, numerous moons, the markings on the disc and polar flattening. A telescope magnifying about 50 times shows the planet of the same apparent diameter as the Moon seen with the naked eye; with this magnification and an aperture of 2 inches, the belts may be seen, but the moons, when not too near the planet, may be seen in any good pair of field glasses.

The equatorial diameter of the planet on the 20th is 37″, whilst the polar diameter is 2″.4 smaller; this polar flattening is readily observed in telescopes powerful enough to see the belts. If sufficient magnification be used, the Great Red Spot on the belt may be seen, and the period of rotation deduced. This is very short, and accounts for the oblateness, being only $9^h\ 55^m$.

The planet appears near the Moon on the 15th, and the star about a degree to the left of Jupiter is the Binary γ Virginis.

The following table gives the satellite phenomena:—

Date.	Satellite.	Phenomenon.	P.M.'s. H. M.	Date.	Satellite.	Phenomenon.	P.M.'s. H. M.	Date.	Satellite.	Phenomenon.	P.M.'s. H. M.
June				June				July			
3	I.	Tr. I.	11 45	14	III.	Sh. I.	11 24	1	II.	Sh. I.	10 7
5	I.	Sh. E.	9 38	19	I.	Tr. I.	9 58		II.	Tr. E.	10 17
6	II.	Tr. I.	10 37		I.	Sh. I.	11 14	2	III.	Ec. D.	9 28
7	III.	Sh. E.	9 46	20	I.	Ec. R.	10 34	5	I.	Sh. I.	9 32
8	II.	Ec. R.	10 49	21	III.	Tr. I.	10 8		I.	Tr. E.	10 32
11	I.	Oc. D.	10 44	22	II.	Oc. D.	10 49	8	II.	Tr. I.	10 10
12	I.	Tr. E.	10 20	24	II.	Sh. E.	10 12				
	I.	Sh. E.	11 33	28	I.	Sh. E.	9 52				

"Oc. D." denotes the disappearance of the Satellite behind the disc, and "Oc. R." its reappearance; "Tr. I." the ingress of a transit across the disc, and "Tr. E." its egress; "Sh. I." the ingress of a transit of the shadow across the disc, and "Sh. E." its egress; "Ec. D." denotes disappearance of Satellite by Eclipse, and "Ec. R." its reappearance.

Saturn (June, R.A. $2^h\ 2^m$; Dec. N. 9° 56′; June 30th, R.A. $2^h\ 12^m$; Dec. N. 10° 48′) is a morning star in Aries, rising at 1.20 a.m. on the 20th. On the 11th July he rises at midnight, practically due East.

Uranus (June 15th, R.A. $19^h\ 46^m$; Dec. S. 21° 45′) is situated in Sagittarius. The planet rises about 10.10 p.m. near the middle of the month, and is on the meridian about 2 a.m. He can just be discerned with the naked eye about 5° S.W. of α and β Capricorni.

Neptune (June 15th, R.A. $7^h\ 18^m$; Dec. N. 21° 36′) is almost out of range, as on the 12th of next month he is in conjunction with the Sun. The planet is only visible for a short time after sunset, as he sets about 9.45 p.m. on the 15th.

Halley's Comet will be practically out of range during June, except for observers with large telescopes.

On account of the bright evenings it has been a somewhat disappointing object, but photographs taken at Kodaikanal Observatory in India, show the comet with a remarkably fine tail full of delicate streamers. Still, to restore public confidence in Comets, another similar to those of 1858 and 1882 is required.

METEOR SHOWERS:—

Date.	Radiant. R.A.	Radiant. Dec.	Name.	Characteristics.
	h. m.			
June—July ...	16 48	−21°	*a* Scorpiids	Fireballs.
June 13 ..	20 40	+61°	*a* Cepheids	Streaks, swift.

TELESCOPIC OBJECTS:—

DOUBLE STARS, &c.—γ Virginis XII.^{h} 37^m, S. 0° 54′, mags. 3, 3, separation 6″.0. Fine double for small telescopes with a magnification of about 80. Jupiter is about 1° W. of the star.

β Scorpii, XVI.^{h} 0^m, S. 19° 33′, mags. 2·7, 5·2; separation 13″.1.

ϵ Lyrae, XVIII.^{h} 41^m, N. 39° 33′, known as the "double-double" star, can just be separated by the naked eye, but with a pair of opera glasses it is readily divided into two components, ϵ_1 and ϵ_2, mags. 4·4 and 4·8. Using a 3-in. telescope and a power of about 120, each of these stars can again be divided into pairs, 3″·2 and 2″·6 apart respectively, each component being about magnitude 5·5.

M 57 (Lyra), the "ring" nebula. This nebula is the only annular nebula accessible to telescopes of about 3-in. aperture, and even then requires good seeing. It is easily found, being situated about $\frac{1}{3}$ of the distance from β to γ Lyrae. The usual appearance in a 3-in. telescope is that of a rather large nebulus star, but it bears magnification well, and its annular character can easily be made out with a moderately high power.

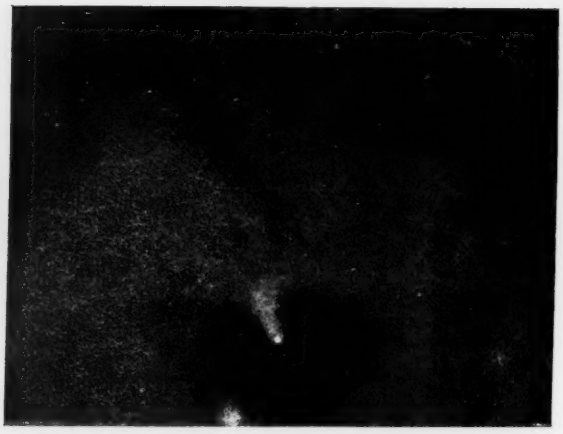
M 80 (Scorpio). A compact globular cluster half way between α and β Scorpii; looks like a nebula in small telescopes.

XUM

October 2nd, 12^h 42^m

October 8th, 11^h 53^m

October 12th, 6^h 5^m



October 12th, 10^h 34^m

October 12th, 12^h 40^m

October 12th, 14^h 24^m

Halley's Comet in 1835.

These drawings originally appeared in the *Astronomische Nachrichten*, Band, XIII, and were reproduced in the "*Abhandlungen von F. W. Bessell*," edited by R. Engelmann, 1875.

XUM

EDMUND HALLEY.

By F. A. BELLAMY, M.A., F.R.A.S.

First Assistant, University Observatory, Oxford.

(Continued from page 168).

In Nov. 1703 Halley was nominated Savilian Professor of Geometry at Oxford and appointed the following year, when he received the honorary degree of D.C.L. The duties connected with that chair he was able to fulfil, whilst holding other appointments and accomplishing much laborious work, for a long period of thirty-eight years, until his death in 1742.

From a painting by Thomas Hudson.

FIGURE 1. Jacob Bradley
Astronomer Royal and Savilian Professor of Astronomy at the University of Oxford.

The second great achievement by Halley was the discovery of the periodic character of comets. Soon after the publication of the "Principia" Halley was anxious to verify, by actual observations of these celestial bodies, and so prove conclusively, Newton's theory of Gravitation. Pre-occupation by other duties,—he had then to work hard for a daily living—seems to have prevented him from carrying out his wish. The appointment in 1704 removed most of his difficulties and he must have immediately fulfilled his resolve. To accomplish this he calculated the orbits of a number of well-observed comets, and after an enormous amount of laborious work, probably very inadequately appreciated in these days of haste, he was able to communicate his more original and most important paper to the Royal Society in 1705, with the title *Synopsis Astronomiae Cometicae.* In that, he gave the elements of twenty-four comets from 1337. By an inspection of these data he was led to believe that the comet of 1531, 1607 (observed by Horrocks) and 1682 (observed by himself, Cassini and others) were one and the same, and that the difference between these years was the period occupied in its orbit round the sun. The cause of the want of complete coincidence in the periods would have presented insuperable difficulties to most inquirers in attempting to establish the identity of comets; but Halley, who, as already mentioned, when twenty years old had correctly explained the causes of the irregularities in the motion of Jupiter and Saturn, was too well acquainted with Newton's principles of gravitation not to perceive that comets might similarly be disturbed in their periods. Saturn, he said, under certain conditions might be changed in its time of revolution through the action of Jupiter by as much as a month. "How much more liable to derangement then is a comet whose excursion into space is four times greater than that of Saturn," he wrote. Uranus and Neptune were of course unknown to Halley.

This is the comet known since as "Halley's Comet," whose return late in 1758 Halley, with much courage and confidence, predicted expressing the hope that if his prediction were successful, he would not be forgotten. The comet was first seen on December 25th, 1758, by an amateur astronomer in Saxony. May we not regard this achievement alone as one entitling Halley to a place among the roll of the most eminent men of science, besides being one of the most brilliant triumphs, both for Halley and for Newton's theory of gravitation? All the astronomers of Europe were then anxiously looking forward with expectation to an event which was destined to exercise such an important and far-reaching influence on the fate or verification of Newton's theory of gravitation. Clairaut re-calculated the time of perihelion passage and in publishing his paper sagaciously remarked "that a body which passes into regions so remote, and which is hidden from our view during such long periods, might be exposed to the influences of forces totally unknown, such as the action of other comets, or even of some planet too far removed from the Sun to be ever perceived." The return of his comet so near Halley's predicted time was then one of the most brilliant triumphs which Newton's theory had achieved and established beyond all doubt that comets are mainly controlled by the Sun. Assuredly his name will similarly endure for all time.

From the portrait in "Historia Coelestis."

FIGURE 2. Flamsteed the first Astronomer Royal.

It was Halley who first observed in England, if he was not the discoverer of, the comet of October, 1723.

Halley's work, after 1705, during the early years of his professorship, was of considerable importance; he learnt Arabic in order to produce, in 1706, a

XUM

version of the treatise by Apollonius; a restoration of two lost books by the same writer; an edition of the Conics of Apollonius, and, in 1710, a treatise by Serenus.

During, and for some years after, these investigations, Halley was concerned, with others, in the publication of Flamsteed's observations. Prince George of Denmark offered, in 1705, to pay the cost of printing the book, which was intended for the benefit of astronomy and navigation. Flamsteed engaged to read the proofs and give time to the MS.; but the printing was delayed by reason of the catalogue being incomplete, by the death of the Prince in 1708, by the reluctance of Flamsteed to assist, by his pre-occupation with observing, and by his infirmity. So Halley was chosen by the others to accelerate the printing and make it perfect; he compared the catalogue with the original observations, corrected errors, filled in gaps, re-calculated the zodiacal stars, and determined the positions of the stars observed by Flamsteed near the Pole, which required much calculation. The catalogue only was published in 1712. Halley wrote the preface, which is held to be ungenerous toward Flamsteed and not in accordance with Halley's nature. There were faults on both sides. Flamsteed was so indignant with the publication without his concurrence that in 1715 he obtained the remaining three hundred copies from the Government (four hundred were printed) and immediately burnt them. He resolved to publish a complete edition in his own way, together with all his other observations previous to 1675 and until 1719; the whole to occupy three folio volumes. Two had been printed at Flamsteed's death on December 31st, 1719, and the third was published in 1725, by his former assistants, Croswaith and A. Sharp.

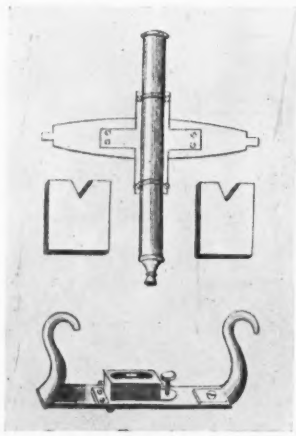


FIGURE 3. Halley's Transit Instrument (after Smith).

In 1713 Halley was appointed Secretary to the Royal Society and held the office until 1721; having during this time, by reason of his two positions, considerable influence in the scientific world. This influence was not lessened by his appointment as Astronomer Royal, to succeed Flamsteed, in 1720.

In 1716 Halley was engaged upon a method for determining the sun's distance by observing the Transit of Venus. He was the first to demonstrate, in 1718, that stars had proper motion in space; this discovery was confirmed by Cassini in 1738. Also in 1718 he wrote a paper on the extreme smallness in the diameters of stars, and substantiated the conclusions arrived at by Horrocks in 1637.

Halley was also the first who remarked that the amount of refraction affecting the altitude of a star varied with the weight of atmosphere. In 1720 he read a paper before the Royal Society.

Halley had been occupying his attention with the rectification of the tables of the planets; he sent the MS. to the printer in 1717 and the tables were printed in 1719. But being appointed soon afterwards to succeed Flamsteed, he suspended their publication, and they remained unpublished until 1749, in order to determine by proper and systematic observations the errors of the lunar theory. His plan was to observe the moon at every opportunity through a whole revolution of its node. When only eighteen years old he had drawn attention to the errors in the lunar places, and then, at the age of sixty-four, depending upon the great natural strength of his constitution, he returned to the subject with vigour, and did not hesitate to enter upon a nineteen years' series of lunar observations.

Halley owed his appointment, as did also Bradley, principally to the intercession of his friend the Lord Chancellor Macclesfield, the most influential man toward science and patron of men of learning in those days. It is known from the memoirs of G. Whiston that he also wrote to the Chancellor Parker to obtain the position for him, but the reply was that he had already spoken to the King for Dr. Halley. Halley soon found an opportunity of publicly expressing his gratitude in a permanent form by dedicating "To the Right Honourable Thomas Parker, Baron of Macclesfield, Lord High Chancellor of Great Britain: Chief Patron of Philosophy and Useful Arts," Vol. XXX of the Phil. Trans., "As a small acknowledgment for very great favours." Besides honour and work, the appointment only included the trivial salary of £100 a year.

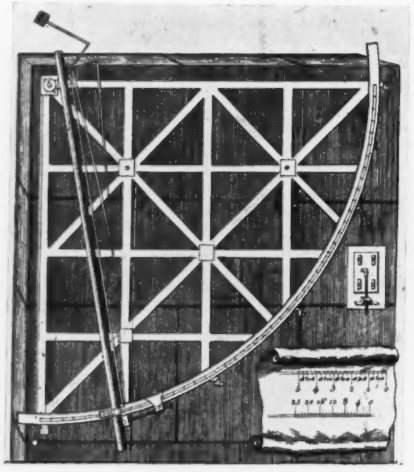


FIGURE 4. Halley's Quadrant (after Smith).

Unfortunately, in one sense, Halley found the Royal Observatory depleted of instruments, papers, and so on, by Flamsteed's executors; so he soon set about obtaining the necessary money, and again appealed to his patron to procure the funds from His Majesty's Treasury. In this he was successful, for we learn from the minutes of the Royal Society Council of May 12th, 1726, that Halley reported that the money advanced by the Treasury had been expended and that more was required. A further report was

presented on May 26th, and the first clause runs thus: "That all the instruments now lodged or erected in the Royal Observatory, and belonging to it, were procured by the present professor. Those which were used by his predecessor being carried off and claimed by his executors," and the report goes on to say "that the several sums have been truly laid out with great frugality and good husbandry." Two hundred pounds more were asked for, but Halley was never able to get it. Halley was at the Royal Observatory and received the visit of Queen Caroline, wife of George II, in 1727. She reminded Halley of his having formerly borne the King's commission, and procured him, for the remainder of his life, the enjoyment of half-pay as a commander in the Navy. It was not until December 1742 that King George II granted Bradley one thousand pounds to complete and restore the equipment.

Halley and Pound had the pleasure of presenting to the Royal Society observations made by Bradley; and it is recorded in the Journals of the Society for October 23rd, 1718, that Dr. Halley proposed Mr. James Bradley, nephew to Dr. Pound, "as a person very well qualified to be a member of this Society, which was referred to the next Council." It is interesting to add that at the Council meeting on November 6th this recommendation was approved and Bradley was elected a fellow the same day; Newton was presiding as President, and Halley was Secretary—an association of three great men.

Edmund Halley was proud of his physical powers, and Hearne says "Dr. Halley (now in the seventy-second year of his age) does not care to be thought old." Indeed, he felt no indication of decay before 1737, the year his wife died, when his right hand was attacked by paralysis. This physical inconvenience did not prevent him from active exertion or the enjoyments of life; he observed with the instruments until December 31st, 1739, and was a very regular attendant at the Royal Society Club dinners—it was mainly due to Halley that this Club originated in 1731—until the disease increased. It was only then that he felt compelled to contemplate the resignation of his position as the head of the Observatory. He was most anxious that Bradley should succeed him; indeed, he was even willing to resign in Bradley's favour: evidence of Halley's kind feeling for others' welfare, and zeal for the advancement of Astronomy. It is pathetic that he did not have the greatest satisfaction of knowing that Bradley was to succeed him. Bradley was appointed on February 2nd, 1742; Halley died on January 14th, 1742, and lies buried in the old churchyard at Lee. It is a strange coincidence that the Earl of Macclesfield's reply to Mr. W. Jones' letter on behalf of his lordship's recommendation and support in the appointment of Bradley should be dated January 14th.

Lalande regarded Halley as the greatest astronomer of England. Delambre said that Halley was, without doubt, one of the most learned men which England and the entire continent of Europe had produced, but he expressed the opinion that, as an astronomer, one had the very best reasons for objecting to Halley being placed in the premier position, preferring Bradley. Weidler, a contemporary of Halley, when describing the St. Helena work, gave the young astronomer the title of "the incomparable." Flamsteed, upon the same occasion, called Halley "The Tycho of the South." These latter exaggerations were for the purpose of contemporary biographical notices or personal pleasantries, but, for a correct account for historical purposes we ought to to try avoid adjectives that are vain, and strive to do equal justice to all. So, while it would be most unfair to attempt to depreciate Halley as a remarkable man and one of the foremost men of science, we must not allow our opinions or esteem for Halley, the Englishman, to be warped by such expressions as incomparable when judging him among such contemporaries as Flamsteed, Newton, Bradley, Cassini, Clairaut, Pingré, and others.

Halley's observations from 1721-1739, made at the Royal Observatory after he obtained the new instruments between 1721 and 1726, are preserved in four small volumes, containing eight-hundred and seventy pages bound in vellum, at Greenwich. With the object of satisfying the desires, frequently expressed, to know more of these observations, the Admiralty, through Capt. Beaufort, had a transcript made; that copy, contained in one large folio volume of five-hundred and eighteen pages, was presented by the Admiralty to the Library of the Royal Astronomical Society, on Dec. 14th, 1832. Francis Baily, then the President, was induced, by reason of the Admiralty's present and for the information of astronomers, to make a digest of the observations recorded therein. He found that an unusually large proportion of the observations were of the Moon. It was unfortunately the opinion of Halley, and of the age in which he lived, that the frequent and constant observation of the fixed stars was of secondary importance; especially after they had been once observed and formed into a catalogue. But this practice does not accord with the views of the modern astronomer. It is fortunate that our older stellar astronomy does not depend upon Halley's material, which is evidently poor in quantity and quality, instead of the abundant and accurate observations by Flamsteed, Bradley, Hornsley, and others, so far as their instruments permitted. Baily concluded that the MSS. are principally valuable for Halley's systematic observations of the moon and planets; but feared that the results to be derived from a reduction of the observations would scarcely repay the time and labour expended.

Rigaud says of Halley, in reference to Halley's opinion upon the finer and more exact observations of Bradley, "In fact, Halley had no opinion of these fine observations," and then quotes Halley's own words in Latin in the Phil. Trans. XXIX 456—"and he must therefore have thought it idle to attempt observing a portion of a second. Accordingly, he never believed a word of the doctrine of nutation,

XUM

although he lived till 1742, when Bradley had already continued his observations for a series of many years, in which he had found the constant operation of this effect. Though Halley's was certainly a very powerful mind, it was not always free from error; for he not only had too much contempt for what appeared to him to be trifles, but he was often too rapid in drawing his conclusions. The effect, however, of aberration amounted to the greater part of a minute in each year, and formed a tangible quantity, the existence of which did not admit of a doubt: Bradley, therefore, when he announced the discovery in his letter to Halley, must have felt secure in his deductions, in this case, of the 'approbation of so great a Judge.'"

Concerning Halley's somewhat hasty conclusions upon other work,—and his judgement seems less trustworthy upon subjects outside his own range,—Hearne says, "Last night, I was in the company of Dr. Halley and Mr. Bradley, our two Savilian professors. Dr. Halley hath a strange odd notion that Stonehenge is as old, at least almost as old as 'Noah's Flood.' But when he is possessed of a notion he very hardly quits it. Dr. Halley is excellent at writing short discourses in mathematicks, but when he dives into other subjects he is whimsical, fanciful and erroneous." Hearne's mind was not of such a giant character as Halley's, so some allowance must be made for Hearne's opinions, but that cannot be said of Newton, who found it necessary occasionally to check the great man, and sometimes even to say to him "Mun! Mun! you talk without thinking."

It would occupy too much space, even if the subject were a suitable one for these pages, to give an adequate explanation of the unfair and uncharitable charges that some of Halley's contemporaries make against his so-called religious ideas. These views were mainly concerned with the age of the earth, and were too advanced for the religious bigots of the earlier part of his life and of that intolerant period; these charges were made by his jealous and envious enemies, and by minds of less ability and capacity than Halley's. Millions of people now hold views similar to those of Halley, without question.

Besides Halley's separate books there are as many as eighty-one papers which were written by him on varied subjects in the Philosophical Transactions.

S. P. Rigaud, at the time of his death (he was Savilian Professor of Geometry, 1810-1827, of Astronomy 1827-1839, and Radcliffe Observer), was engaged upon an exhaustive biography of Edmund Halley, and had already collected and preserved in manuscript a considerable amount of information. It is earnestly desired that this much too long delayed biography and volume of collected papers may yet be accomplished by the facile pen of the present energetic and eminent successor to Halley's professorical chair, and form a companion volume to Rigaud's "Life of Bradley." Towards this the present writer would be delighted to devote all the time he could, in the mere collection and mechanical part of the work.

In bringing this necessarily brief notice of Halley to an end, it may be mentioned that reference to the present return of Halley's comet, and other returns since his time have been essentially avoided, as also the recent work by Dr. Cowell and Dr. Crommelin, who, besides foreign awards, were rewarded by the conferment of the honorary degree of Doctor of Science, at Oxford on May 21st, and the papers by Professor Turner and others, bearing upon its appearance and observations in 1909 and 1910. Much on that phase of the subject has already appeared in print; besides, it would suffice for a separate article. But, it will not be out of place to remark that in view of the general disappointment that prevails in this country and most of Europe, especially the northern parts, at the poor appearance of and difficulty in seeing Halley's comet, or at least its tail, is neither the fault of Halley, the tail, nor the calculations; it is due to the unfortunate coincidence of perihelion passage, early summer (long twilight) and bright moon, when the earth and comet were nearest to each other. At the 1835 return excellent opportunities for telescopic and general observation occurred, as it was then favourably situated for observation between September and March, 1836, in dark skies,—quite the reverse of the conditions prevailing upon the present occasion, the long and strong twilight being the chief cause of our inability to detect the comet's tail.

The beautiful representations of the appearance of the comet in 1835 in Bessel's memoirs, so well show its general features from May 24th to 26th, 1910, that we reproduce some of the drawings as a frontispiece to the second portion of this article.

A NEW LIST OF ASTRONOMICAL WORKS.

After an interval of ten years Messrs. William Wesley & Son have issued a classified catalogue of more than three thousand six hundred manuscripts, books and pamphlets on Astronomy. These are entered under no less than thirty five headings, so that it is easy for anyone who is studying a special subject to refer to it. Included in the collection are the libraries of Captain E. Noble, Mr. E. Crossley, Mr. A. A. Common and Miss A. M. Clerke. It is claimed that the list contains more than fifty works which are not described in the catalogues of the Royal Astronomical Society of London. By the expenditure of a considerable amount of time Messrs. Wesley & Son have been able gradually to get together complete series of periodicals, such for instance as the Philosophical Magazine, which runs from 1798 to 1908, and the Philosophical Transactions of the Royal Society, from 1668 to 1908. We feel sure that our astronomical readers will find the new list of special interest, and we may add that it will be sent (from 28, Essex Street, Strand, W.C.) post free to any address on receipt of one shilling.

LIFE, LATENT LIFE, AND DEATH.

By DAVID FRASER HARRIS, M.D., B.Sc. (Lond.)

Of the University, Birmingham.

To the ordinary person nothing seems easier than to distinguish between life and death, or, to be more exact, between a living and a dead animal. Such a person at once thinks of the warm, breathing, moving organism, with its beating heart and its perceptions of the outer world, in contrast with the cold, still, unconscious corpse in which the heart has stopped for ever.

But even were the biologist asked to enumerate the differentiae between the living and the dead, he too would proceed with no less hesitation somewhat as follows:—

> Living matter can exhibit (1) metabolism or continual exchange of matter between itself and the environment; (2) can transform the potential energy of "food" into the kinetic forms of heat, bodily work (internal and external), and the exhibition of electric current; (3) has affectability or the power of responding to a stimulus, the "responses" being movements of various kinds, including those distinguished as "reproductive."

Pressed for the chemical signs indicative of what he calls "metabolism," the biologist would say they consisted in—(1) the absorption of oxygen in virtue of reducing-power; (2) the excretion of carbonic acid gas, water, and other substances more or less hurtful to the organism if retained; (3) the taking in of "food" or material dissimilar to the substance of the tissues and building it up into these very tissues, that is, incorporating or *assimilating* it.

Clearly none of these things is evinced by a corpse, so that it is easy to distinguish between the extremities of the vital scale—complete livingness at the one end and undoubted death at the other.

But there may exist theoretically, and there do exist actually, certain degrees of partial livingness or apparent death—phases of depressed vitality so closely resembling death as to be indistinguishable from it, at any rate by one's unaided senses, or without the assistance of the elaborate and delicate instruments of a modern physiological laboratory.

Certain persons, for instance, live in constant fear of premature burial—are afraid that their life will be extinguished so gradually that at a time when they are still alive they will be judged to be dead, and buried accordingly. Quite recently a case was reported from Spain of a girl having been prepared for burial while still living, and having had the strength to break open the coffin-lid. They would be amongst those who believe it is not easy to discriminate feeble degrees of livingness from actual death.

Again, are the dried seeds one buys from the seedsman, or which are alleged to have been brought from the hands of Egyptian mummies, alive or dead? The practical test, of course, is to see whether they will germinate; if they do you have gained a plant, but lost your seeds as such; if they do not grow they were presumably dead. But by such a procedure you will find out what your seeds *were*, not what they *are*. It is like dissolving your coin in aqua regia only to discover that it *was gold* because it has now dissolved away.

We must have tests of such a kind that they do not injure the substance under examination, or alter its condition. Of these two are chemical and two are physical:—

Is any oxygen absorbed, is any carbon dioxide given out, is there evolution of heat, is there developed, after stimulation, any difference of electric potential? If so, the substance, vegetable or animal, is certainly alive. According to the eminent English physiologist, Dr. A. D. Waller, the most delicate and infallible of these tests is the last; so that he has called the exhibition of an electric current "the last sign of life."

Turning to dead things, the signs of death are the absence of gaseous interchange, of heat and of electric response. (Of course there *is* such a thing as the post mortem development of heat within a corpse, but it is a purely temporary affair). *The* sign of death is a corpse, and in a corpse there will sooner or later be putrefaction or bacterial fermentation, unless, that is, by special precautions, naturally or intentionally, prevented. Thus, since each of the simplest Protozoa always divides into two halves or reproduces itself, instead of dying, Metchnikoff has alluded to Amoebae and Paramoecia as "immortal." In a certain sense, even in the highest animals, undyingness is exhibited by such portions of their substance as are detached, as eggs, or ova, and grow up to be independent individuals. This "continuity of the germ-plasm," as Weissmann calls it, is, according to him, the physical basis of the hereditary transmission of ancestral attributes.

Putrefaction is indeed a sign of death, but the white-of-egg can putrefy and yet it is not dead, because it never was alive. The white-of-egg is the product of a living being, just as sugar, or urea is; but white-of-egg is no more alive than they are. Putrefaction is a fermentation: white-of-egg can ferment; so can sugar and so can urea. Fermentation in the dead merely indicates that, chemically, the dead is now *organic* matter: but it was once *organised* matter, which albumen, sugar and urea never were. Putrefaction is, indeed, as truly a sign of *life*—of micro-organic life—that is flourishing exceedingly on the chemical substance of the dead organic matter. The chemical line of descent here

XUM

is: bioplasm, or organised matter, chemically very complicated, the physical basis of life; then organic matter, and lastly inorganic matter; *e.g.*, nitrates and nitrites of ammonium and ammonia itself: that is the chemical *facile descensus*.

The corpse putrefies because, being lifeless, it cannot resist the inroads of the bacteria; which it did more or less successfully while it was alive. It has no longer any affectability towards the bacteria, no longer reacts towards them by preparing anti-bodies for their poisons, bacteriolysms, and so forth, to destroy them.

Affectability is *the* sign of life, the first and the last, the alpha and the omega of livingness: even the electric manifestation is but one result of bioplasm possessing affectability at all; if the affectability were gone there could be no development of electric current. But the egg-albumen never had affectability, and therefore never had life: it gives no electric current.

But there is a state known as "latent life" which is a particularly interesting one, for the organism having all the appearance of death (Scheintod) can nevertheless once again manifest vital characteristics.

Ever since the discovery of the dried Rotifers by the diligent Dutch histologist Leeuwenhoek, in 1719, we have known that animal organisms can exist for years in a dried up state in dust or mud and "come to life again," as it is said, on being moistened. Of course they have never been dead, for death is the permanent impossibility of manifesting life in that which once lived. Not only Rotifers, or wheel-animalcules, but Tardigrada, or bear-animalcules, can survive this extreme degree of desiccation. Both these classes of animals actually possess digestive and nervous systems, for they are by no means of the most primitive type: they take from twenty minutes to an hour or two to revive on being moistened. Other animals capable of withstanding the abstraction of water are the Anguillulidae, or paste-eels, and certain Infusoria, if we set aside as apocryphal the tales of frogs shut up inside pieces of marble or coal, and jumping out of these when the blocks were broken open. In the plant-world we have dried seeds retaining their vitality for very long periods, although the stories as regards seeds from Egyptian mummy-cases being able to germinate are not now believed. We know that grain dug up from subterranean Roman granaries is "carbonised," or black, as though scorched, and that it does *not* germinate. Mariette, the Egyptologist, definitely denies that mummy-wheat germinates; placed in water it disintegrates to a clayey pulp. Nevertheless it is quite true that seeds in a dry state for as long a time as two hundred years, have produced seedlings, —in other words, have been alive all the time.

Bacteria, the lowest plant organisms, have enormous powers of resisting conditions that tend to death. The late Professor MacFadyen showed that the bacteria of certain diseases frozen at the temperature of liquid air (about minus 200° C) were not killed, but could survive so extremely drastic a procedure as this and yet retain their specific vital pathogenic characteristics. When frozen they were so brittle that they could be powdered in a mortar they were nevertheless still in the state of "latent life."

Coming to the cold-blooded animals we have many instances of suspended animation amongst such creatures as snails, water-beetles, frogs and fish. The best instances are of fish when frozen. Sir John Franklin, in his Polar expedition of 1820, reported carp fish frozen so solid that the intestines of some of them could be taken out en masse, yet on being thawed before a fire they "revived and moved about actively." Preyer, the German physiologist, had evidence that frogs frozen solid could be revived if their internal temperature had not fallen below 2·5° C. Fishes frozen in a block of ice to minus 15° C have been known to revive, although some of their companions were frozen so hard they could be powdered up along with the ice. According to the French experimenter, Raoul Pictet, frogs endured a temperature of minus 28° C. and fish a degree or two below minus 15° C. These are all cases of "latent life" at low temperatures.

The application of this principle of cold arresting life is that of the storage of carcases of animals killed abroad; New Zealand and Australian mutton. The bacteria of decomposition are in a state of latent life all the time: they are not killed, for on the temperature rising again, putrefaction can set in and destroy the frozen meat, as every one knows. The meat is, of course, dead, but not so the bacteria on it; they are in a condition of "latent life."

Sir Ernest Shackleton reports that in the South Polar seas there are marine organisms frozen up in the ice for ten months in the year: they move about only during the other two.

Ascending to the warm-blooded animals and to man himself, we do not find such extreme instances of suppression of vitality as in the case of lower organisms—creatures with more sluggish, and therefore less easily deranged, metabolism.

All states of trance or narcolepsy—extremely deep, prolonged apparent sleep—such as the famous case of Colonel Townsend, reported on carefully by Dr. Cheyne, of Dublin, belong to this category. This case is very well known to medical men, but is, perhaps, not so familiar to others that the following quotation of Dr. Cheyne's words will be superfluous: —"He could die or expire when he pleased and yet . . . by an effort he could come to life again . . . He composed himself on his back and lay in a still posture for some time. . . . I found his pulse sink gradually, till at last I could not feel any by the most exact and nice touch. Dr. Baynard could not feel the least motion in the heart, nor Mr. Skrine perceive the least soil on the bright mirror he held to his mouth . . . could not discover the least symptom of life in him. We began to conclude he had carried the experiment too far; and at last we were satisfied that he was actually dead and were just ready to leave him. . . . By nine in the morning . . . as we were going

away, we observed some motion about the body and upon examination found his pulse and the motion of his heart gradually returning: he began to breathe heavily and speak softly."

Still more extraordinary are the narratives of the Fakirs in India, who are said to allow themselves to be built up in sealed tombs for weeks without food, and to be alive at the end of that time. Reports of these cases of human suspended animation are now too numerous, and too well-authenticated by European eye-witnesses of unimpeachable integrity, to be set aside as either in themselves untrue or due to collective delusion.

James Braid, the first investigator of hypnotism, has narrated a case, typical of many others, in which a Fakir was tied up in a sealed sac, which was placed inside a locked box, which was left for six weeks in a sealed up dark room in the palace of Runjeet Singh. The man's ears and nostrils had been blocked up with wax, which was still there when the body was brought into the light at the end of six weeks. On the sac being opened the muscles were found quite stiff, the jaws tightly clenched, and no trace of a pulse beat was to be anywhere detected. By degrees the man revived, the muscles softened, the pulse began to be perceptible, and in a feeble voice he asked "Do you believe me now?"

The interesting inference from all these cases of "latent life" or suspended animation is, that, though vitality cannot be said to have vanished, yet the organism during the time of the latency is giving none of the signs of the possession of vitality. It is not taking food, oxygen or water; it is not giving out carbon dioxide or water, or other chemical result of livingness: it is not moving: in the higher animals both the cardiac and respiratory activities are in abeyance.

No state could be more like death; infinitely more like it than sleep. Latent life, not sleep, is the true image of death. Revivability, however, was there: life was depressed, inhibited, masked, but not abolished. A scheme may help to make these things clear:—

- Matter
  - Non-living
    - Inorganic *e.g.*, Sodium Chloride.
    - Organic
      - Formerly alive, organised: now dead (*i.e.*, incapable of living again).
      - Not formerly alive; not organised, *e.g.*, sugar, urea, starch, white-of-egg.
  - Living (organism)
    - Actually now alive.
    - Potentially alive — In latent life (Scheintod), *e.g.*, dried seeds, animalcules, frozen fish, frogs, bacteria: prolonged trance, narcolepsy in homo.

Recently some very interesting and successful efforts have been made to revive the apparently dead heart in an actually dead body. The following quotation is not from a book of fairy tales, but from a highly technical work on physiology, published about a year ago:—

"Hearts can be revived many days after death—even the hearts of children dead of disease. In ten such cases only three gave negative results. The heart of a boy dead of pneumonia revived in all parts twenty hours after death. In the case of the heart of an ape, Hering recovered the heart after four-and-a-half hours and then froze it. After twenty eight hours thirty minutes, the heart was again resuscitated."

Of course this does not mean that these hearts began to beat again in situ, but that, by prolonged massage, an apparently dead heart can revive sufficiently to give a series of spontaneous beats.

Now on reflecting on these examples of latent life, it will be seen that we must here have cases of interference with the full *mobility* of the molecules of the living substance, whether that has been brought about by abstracting water or abstracting heat. The absence of food, as in hibernating animals, tends very much in the same direction—enfeeblement of the vital processes, so that the bears, dormice, hedgehogs, tortoises, frogs and many other animals which enter on a winter sleep and eat nothing during that time, although they are not in the state of typical latent life, are yet in a state of extremely depressed vitality. Some of them actually cease to breathe though the heart beats. It is a question of degree of livingness.

We must, in fact, recognise that there are *degrees* of life or of livingness in each cell, tissue, organ and organism. Some tissues are intensely alive, some are already dead, for instance enamel of tooth and horn of nail. At the very time when Horace said *non omnis moriar*, he was not even altogether alive. We can construct a scale passing through all degrees of corporate livingness, from the tremendous physical and mental power of a Gladstone, a Kelvin or a Helmholtz, down to the stupidity of a country yokel, or the hopeless sufferer from acute melancholia. In melancholia all the tissues are demonstrably less alive than in the normal person; less oxygen is taken in, less urea and carbon dioxide are excreted, and less heat is evolved. Constipation indicates the inactive intestine; the atrophied, dull-coloured skin indicates the inactive skin. Melancholia is not merely a question of the dull brain; glands, muscles, heart, skin, intestine, all are dull, and relatively lifeless.

There is, in other words, for any given tissue no hard and fast line between the fullest vitality at one end of the scale and eternal death at the other. As one nears the death-point we pass through the stage or state of "latent life." While the extremes are quite distinct, the intermediate stages are indistinguishable from one another. Just as in the case of the visible spectrum: no one can fail to distinguish the red from the violet, yet there is an infinite number of gradations of colour between red and green, and between green and violet.

Assuming, in the meantime, that we can get no better conception of the modus operandi of living matter than by conceiving of it as due to molecules,—no doubt of great complexity—endowed with chemical affinity, and therefore obeying certain chemical laws, we seem to have to admit that, within limits, life is more intense as the temperature rises and less intense as the temperature falls. This behaviour is exactly that of substances capable of chemical interaction, so that, viewed from the purely physico-chemical

XUM

standpoint, life is the outcome of chemical activities. This is by no means a new position, but it is at present the only position from which one can advance to explain latent life.

Latent life is the *temporary* immobilisation of molecules of living matter without the destruction of these atomic affinities which are the chemical basis of life, whereas death is such permanent molecular immobilisation that certain atomic affinities are abolished. The writer has suggested that living matter in latent life and certain allied states of extreme physiological insusceptibility to stimulation should be described as exhibiting the "functional inertia of protoplasm."

Of course death is not the destruction of *all* atomic affinities in the molecules of the once living stuff, but it is the abolition of such as enabled the living matter to link on to itself material from outside, incorporate some of it, oxidise and reject the rest—in short, feed, absorb, and excrete.

In intensely living matter the molecular whirl is most intense; in latent life the molecular whirl is arrested; but when the arresting state—loss of water or of heat—is removed, the whirl can recommence.

In latent life the weights of the protoplasmic clock have been seized by a mysterious hand; in death they have descended to the utmost length of the cord. The vital clock in the one case has only been arrested; in the other it has run down and cannot be wound up again.

There is a good deal of difference in a descent between a stoppage and the end reached: or to take another analogy; in life the "sands of time" are running out rapidly; in latent life the stream has been stopped; in death the sand is all in the lower globe.

Molecular mobility is, then, in technical language, the necessary physical condition for vitality, and any agencies or reagents which diminish that mobility, tend to render life latent, and thereafter to extinguish it.

On this partial molecular immobilisation depends the efficacy of a large number of our drugs and the action of many poisons. To abolish consciousness we administer chloroform, a substance which, by uniting with certain of the chemically active radicles constituting the living matter, immobilises the whole molecular complex.

This immobilisation of the molecules of the cells of the cerebral cortex has its psychical correlative in the disappearance of consciousness. But the chloroform really tends to immobilise heart-cells and cells of the breathing centre as well, and what the surgeon wants is the former—cerebral immobilisation, or anaesthesia—without the latter (death).

The cyanides (Prussic acid) for some reason not yet fully understood, act as such deadly poisons because with great rapidity they immobilise the cells of the respiratory centre.

Thus, the solution of our problem, What is latent life? seems capable of being stated in the terms of the already known. The organism in latent life is not dead, for it is capable of living again; it is, however, very far from being fully alive, for it is manifesting none of the attributes of livingness.

Without a chemical theory of living matter, "suspended animation" would be inexplicable; and while one would freely admit that a chemical conception of vitality is only a partial one, a good working hypothesis; yet at the same time we gain a fuller insight into what life is and what death is not, than if we attempted to enunciate either condition in terms outside of physics or chemistry altogether. In a sense very different from what the author of the lines meant it, yet in a sense profoundly true—

> "'Tis not the whole of life to live,
> Nor all of death to die."

SOLAR DISTURBANCES DURING APRIL, 1910.

By FRANK C. DENNETT.

THERE has been a very small amount of spot disturbance during April. Upon seven days, April 4th, 5th, 6th, 7th, 25th, 27th and 28th, only faculic groups were seen, whilst on 8th and 26th, the disc appeared quite free from disturbance of any kind. The longitude of the central meridian at noon on April 1st was 326° 29′.

No. 25.—Remained on the disc from the previous month until April 3rd, and so reappears on our chart.

No. 28.—First seen on 9th at the western border of a great faculic disturbance. On 10th some tiny pores were seen east of the spot, which was 12,000 miles in diameter. The spot contained three umbrae, and by next day had separated into three spotlets, which dwindled to pores and were last seen on 17th. Apparently a return of No. 27.

No. 28A.—A group of pores, 22,000 miles in length, only seen on 16th, a little south-east of the last.

No. 29.—Two tiny pores almost lost in the northern border of the faculae following No. 28, only observed 11th and 12th.

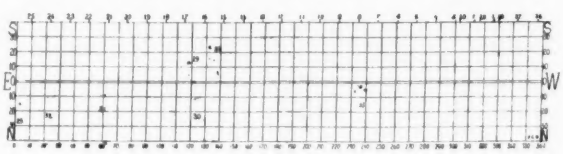
No. 29A.—A group of about four pores, 33,000 miles in length, in a disturbed-looking area, only visible on 15th-16th.

No. 30.—A group of six pores, 30,000 miles in length, 14th to 16th.

No. 31.—Two pores, the eastern being largest, were seen on 19th; one having two umbrae was still visible 21st, but not after.

No. 32.—On 22nd a hazy pore was seen, which had become black next day, and when last seen 24th.

No. 33.—Two spots, surrounded by faculae, just within the limb on 29th, with some tiny companions 30th, and a tiny attendant 9° east; this, however, was not seen again. The two spots formed the western boundary of a rugged looking area, the eastern border being marked on May 3rd by four pores. The group was very active and on 7th was 60,000 miles in length, the largest spot being 10,000 miles in diameter. On the 9th and 10th the eastern spot increased, and the group was followed by a considerable amount of faculae, but on 11th only one black spotlet was visible near the limb.



Our chart is based upon the combined observations of Messrs. I. McHarg, A. A. Buss, E. E. Peacock, and the writer.

STEREOSCOPIC TRANSPARENCIES.

By T. E. HEATH, F.R.A.S.

STEREOSCOPIC photographs are so much better than ordinary photographs for illustrating scientific instruments, anatomical preparations and travels, that this article, though it is founded on my experience in ordinary work, may be useful to scientific men.

As our eyes are about $2\frac{1}{2}$-inches apart, it is obvious that, if stereoscopic pictures are to look like Nature, the two stereograms must be taken with a camera which has lenses about that distance from each other. The separation may be $2\frac{3}{4}$-inches, without making any appreciable difference, but anything beyond $2\frac{7}{8}$-inches should be avoided. If the pictures are to be looked at comfortably, and without strain, they must be mounted no further apart than will make the centre of each approximately opposite the pupil of each eye. It follows, then, the stereograms must not exceed about $2\frac{1}{2}$-inches in width, and it is practically no use exceeding about $3\frac{1}{4}$-inches in height. Some very successful stereograms are made only $1\frac{3}{4}$-inches wide, which, mounted, $2\frac{1}{2}$-inches from centre to centre, and viewed in a stereoscope having lenses of about $3\frac{1}{2}$-inches focus, fill the field; for stereoscopic purposes only this size is ample. Personally, I prefer $2\frac{1}{2}$-inches wide, because sometimes lantern slides are wanted from the negatives.

Forty or fifty years ago stereoscopic pictures were really popular in this country. Expensive stereoscopes and excellent sets of stereoscopic photographs were to be found in every house, and these were about $2\frac{1}{2}$-inches from centre to centre. Unfortunately, the Americans took the matter up and introduced cameras with lenses $3\frac{1}{4}$-inches from centre to centre, which would make stereograms $3\frac{1}{8}$-inches wide after trimming. These were not appreciated in this country. They give an exaggerated stereoscopic effect. Distant objects look near and trees in the foreground look like those cut out for stage scenery. If, however, there be no near foreground their defects are not conspicuous, and the negatives can be used, provided the prints are cut down so that they can be mounted about $2\frac{1}{2}$-inches from centre to centre. If they are mounted $3\frac{1}{4}$-inches from centre to centre there is a constant strain on the eyes when viewing them in a stereoscope. This is probably, though the public and even the dealers do not know it, the reason for their want of popularity.

Now stereoscopic pictures mounted about $2\frac{1}{2}$-inches from centre to centre can not only be seen through a stereoscope without the slightest strain, but they have the great additional advantage that a very little practice will enable most people to see them stereoscopically without apparatus. It is quite possible, therefore, to use them for illustrating books.

This is so important, particularly for scientific works, that I am collecting statistics from all who will take the trouble to make a fair trial and send me a post-card. My correspondents take great interest in the experiments. At present the total is fifty-four, divided as follows: Could previously see stereoscopically without apparatus 20·4 per cent.; not previously, but on first trial almost immediately, 24·1 per cent.; not exceeding half a minute, 11·1 per cent.; not exceeding one minute, 7·4 per cent.; not exceeding two minutes, 16·6 per cent.; not exceeding five minutes, 5·6 per cent.; failed first trial but afterwards succeeded, 9·2 per cent.; and failed, and presumably gave up, 5·6 per cent. Post-cards should be addressed to me at 4, Stanwell Road, Penarth.

The method is to hold the pictures parallel to the eyes at the distance for reading very small print, using, if necessary, spectacles. Look straight forward, as if at a distant object, but focus on some conspicuous object in both pictures. To prevent both eyes from seeing the same picture you may hold a foolscap envelope vertically between them. Most people can do without this help. Suddenly, or gradually, the two pictures coalesce and stand out in stereoscopic relief. Some correspondents think they squint; this is not so, as one picture is opposite each eye. A doctor has watched me carefully. The muscular effort is to prevent the eyes from squinting as usual in reading. Some people may find it easier with pictures nearer than $2\frac{1}{2}$-inches from centre to centre; if $1\frac{1}{2}$-inches is the distance, the eyes converge a good deal. Do not try for more than five minutes at one time, or if one eye differs much from the other, or there is bad astigmatism.

It may be in the recollection of some of my readers that I had to go rather deeply into stereoscopic matters in connection with my star charts. After I had finished them I thought it well to take up photography again. I had dropped it for several years, all my spare time being occupied in painting. I thought stereoscopic photography would give me something I could not get better by painting; at least I had never heard of an artist painting stereoscopic pictures, though I had used my knowledge of perspective to draw my stereoscopic star charts.

After three years' experience, it may be worth while describing my method of work. I began with paper prints but have now, for my own use, discarded them in favour of transparencies on glass. My camera has lenses $2\frac{3}{4}$-inches from centre to centre. I always use roll films, which do not, like plates, require backing. I develop with a daylight machine, and my experience is that films so treated, though they cost a good deal more than plates to buy, show, for each really good and brilliant negative produced, about the same expenditure. Even were it otherwise, for stereoscopic work, films are far the best, because they can so easily be cut.

I have a card and cut therein two rectangular openings $2\frac{3}{4}$-inches from centre to centre (because that is the separation of my lenses) and each $2\frac{1}{2}$-inches wide and $3\frac{1}{2}$-inches high. I move this over the negative till I find the best portion, and

XUM

then prick with a needle the clear celluloid at the top and bottom corners (my film is $3\frac{5}{8}$-inches wide and about $\frac{1}{8}$-inch at top and bottom is clear celluloid after fixing). I make two additional needle pricks near the top inner corners; these become outer corners when the film is cut and reversed and prevent mistakes. The negatives are cut with a sharp knife according to the needle pricks, so that they are $2\frac{1}{2}$-inches wide, and in my case this only means trimming off a little, but the procedure is the same if the camera has lenses $3\frac{1}{4}$-inches apart. The rectangular openings in the cardboard are still each $2\frac{1}{2}$-inches wide, but they are spaced $3\frac{1}{4}$-inches from centre to centre. One of my friends brought me a lot of negatives made with a $3\frac{1}{4}$-inch camera, and I dealt with them. No doubt a good many of my readers have made lantern slides by contact, and found that, though they were obliged to leave out a good deal of the negative, the results were improved. So I found in cutting down my friend's negatives. I often cut my own negatives to less than $2\frac{1}{2}$-inches wide. For pictorial effect a narrow angle is desirable. Photographers often try to get as much as possible on their plates, whereas an artist carefully considers how much he can leave out of his picture with advantage.

The negatives being thus cut, the right-hand stereogram is put to the left, and they are turned face to face, so that the inner edges are together. I take rubber adhesive plaster, about $\frac{3}{8}$-inch wide, and cut off pieces $\frac{1}{8}$-inch wide. I stick one strip over the clear celluloid at the top inner corner and one at the bottom corner. The films are opened out and it will be found that they are separated by a space of about $\frac{1}{3\frac{1}{2}}$-inch. If they are now printed on a post card ($5\frac{1}{2}$-inches by $3\frac{1}{2}$-inches) there is a dark line $\frac{1}{3\frac{1}{2}}$-inch wide separating the two pictures, and dark lines nearly $\frac{1}{4}$-inch wide at each end. At the top and bottom where the celluloid is clear the print will be dark, but the sticking plaster will show white. Therefore, either before or after printing the negative, make the top and bottom of the post-card black in the sun whilst masking the middle of the print.

For my own use, instead of post cards, I get transparency plates made the same as lantern plates. If the lantern plates, $3\frac{1}{4}$-inches square, cost 1s. per dozen, the $3\frac{1}{2}$-inches by $5\frac{1}{2}$-inches transparency plates will cost 1s. 7d. per dozen. I print and develop as if for contact lantern plates, but carry development further, because they are going to be illuminated by a strong light, which has not, as is the case with a lantern plate, to be, after passing, spread over a large area. I am thus able to bring out all which is on the negative.

No mask is required. There is printed the thin dark line separating the two stereograms and the end at each side is dark also. For the top and bottom I cut the waste black paper from the roll films into strips $1\frac{1}{4}$-inches, 1-inch, $\frac{3}{4}$-inch, $\frac{5}{8}$-inch, and $\frac{1}{2}$-inch wide, and $5\frac{1}{2}$-inches long; $\frac{3}{4}$-inch and $\frac{5}{8}$-inch will most often be required; occasionally a very wide or very narrow strip may be wanted. The strips are brushed over with mounting paste, doubled over and pressed down on the cover glass and transparency along the top and bottom. To protect the ends, similar strips $\frac{3}{8}$-inch wide and $3\frac{1}{2}$-inches long are used. The width of the strips used will depend upon how much foreground or sky it is desirable to cover. Before printing I am careful to adjust the transparency relatively to the negative so that the horizontal line is in the best position. With hand camera work this is very necessary, but as I always use a spirit level on the camera no other adjustment is required.

For illuminating the transparencies I use an incandescent gas light of about seventy candle-power. Electric or oil light of equal power would do. I have a box, the inside of which is blackened, $6\frac{3}{4}$-inches long, $5\frac{7}{8}$-inches wide and $3\frac{3}{8}$-inches deep, inside. One end is closed by opal glass (the grain of ground glass would show), and about $\frac{1}{2}$-inch therefrom there is on either side a vertical groove, which is large enough to admit easily the thickest and biggest transparency. The plates are dropped through a slot at the top of the box, and there is a rim $\frac{1}{8}$-inch high across the bottom to prevent light passing except through the transparency; also a black cardboard division extending 2-inches back from the transparency to prevent one eye seeing both pictures. I should have mentioned that, to lift the transparency from the box, I have a black linen tag (about 2-inches by 1-inch) pasted to the top of each, and over the tag and along the paper at the top of transparency I paste a red paper strip on which I write the title. The other end of the box is open and the bottom at that end is cut away where required to allow one of the ordinary American stereoscopes to be pushed in, its tail piece sliding in a groove formed below the box, so that the focus can be adjusted. I use spectacle lenses to reduce the distance from the transparency to the eyes, to about 6-inches. I have a stand for the box which supports it above a table, so that the centre of the opal glass is the same height as the light (say, 14-inches). There may be one light in the middle of a table and four dark boxes round it, but the opal glasses should not be more than eight or ten inches from the light. I keep the transparencies in plain wooden boxes, which hold about fifty each.

The effects are striking. If the reader takes the method up he will probably find his friends, like mine, say they never saw photographs so well before. The small size (which makes for economy and depth of focus) is not felt at all. The spectator seems to be looking at the place itself, or at the actual object or person, and can make out details and structure which it is impossible to understand from an ordinary photograph. The range of values is so great that, if the scene was photographed on a sunny day, you see real sunshine. The work is easy and cheap by the method that I have described in the foregoing pages. The only disadvantage is that anyone who adopts it may as well give away his other cameras, for he will never use them again.

XUM

FIGURE 1. Sunrise at Penarth.

FIGURE 2. Penarth Pier in a South East Gale.

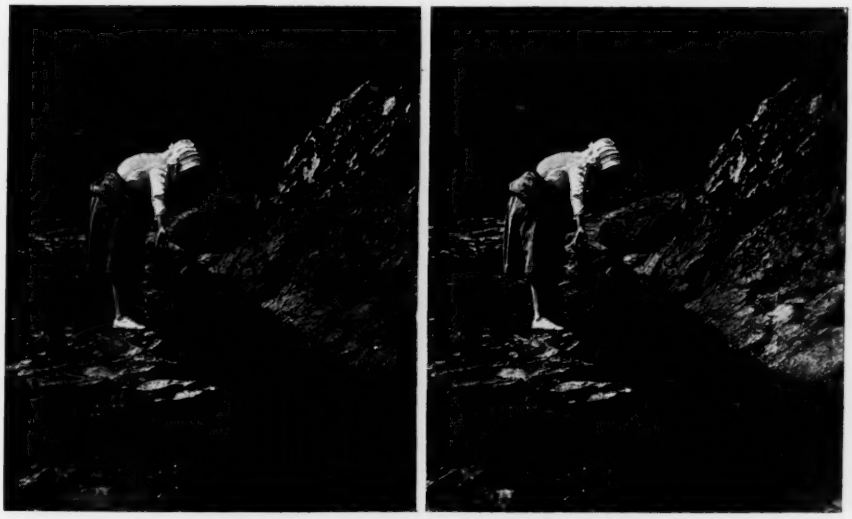


FIGURE 3. Prawning.

XUM

THE CLAIMS OF THERMO-CHEMISTRY.

By H. STANLEY REDGROVE, B.Sc. (Lond.), F.C.S.

If by the term "Science" we understand exact knowledge of natural phenomena, then it follows that the study of phenomena becomes scientific in so far as it involves measurement. Now, all those changes which we call "chemical" may be regarded from two different points of view, and admit of measurement in two different ways. All chemical bodies, that is to say all "substances," in the common, non-philosophic meaning of the term, can be regarded as things which resist change of rest or motion, that is to say, as things possessing so much inertia.* Now, the inertia relations involved in chemical changes admit of measurement. It has been proved experimentally that the total inertia is always constant during a purely chemical reaction—a fact expressed by the Law of the Conservation of Mass (or Inertia), very often miscalled the Law of the Conservation of Matter,—and certain definite and important ratios have been discovered between the inertias of the reacting bodies, which have been generalised into the Stoichiometric Laws. Indeed, what is generally understood as being Chemistry (or quantitative, as distinguished from purely qualitative and descriptive chemistry) consists in the study of these inertia relations.

Chemical changes, however, may be regarded from another point of view. A chemical compound may be regarded as an energy complex; and, just as every definite chemical change involves certain definite inertia relations, so does every definite chemical change involve definite energy changes.

In some chemical changes definite quantities of energy are given out—generally in the form of heat; —other chemical changes only take place provided energy—again generally in the form of heat—is supplied to the reacting bodies from without. It is primarily the function of Thermo-Chemistry to measure these energy changes.

Now these two points of view are not antagonistic, but rather complementary. If, however, it be asked, which of these two ways of regarding "chemical substances" is the preferable, we are inclined to answer the latter; for it seems not at all unlikely that the explanation of inertia will ultimately be found in terms of energy.

This may make it appear all the more surprising that "Gravimetric" or "Inertia Chemistry" should have exalted itself so far above Thermo-Chemistry. Let us admit merely that the two points of view are equally valid, and it becomes apparent that the study of the energy changes involved in chemical reactions has been very seriously neglected in comparison with the study of the inertia relations involved in the same. But, although there is no real justification for the neglect of Thermo-Chemistry, there are reasons which have led to this neglect. One of these is the experimental difficulty connected with even the simplest thermo-chemical determinations. Another reason we shall note later.

It will be universally admitted that no doctrine has played so important a part in the development of chemical science as Dalton's Atomic Theory. It is true that recent researches in the domain of physical science indicate that the atomic theory is not absolutely true; but it is now recognised that a scientific theory may be of very great value as an organon of thought leading to further discoveries without being absolutely true, and as to the great utility of Dalton's theory as an organon of thought there cannot be any doubt.

Now, according to the atomic theory, a chemical compound may be regarded as a complex of chemical atoms. Thus, ethyl alcohol can be represented by the formula—

C C H H H H H H O,

or, more simply—

C_2H_6O,

where C represents an atom of carbon, H an atom of hydrogen, and O one of oxygen.

This formula has a quantitive significance; it indicates the inertia relations between the elements entering into the constitution of this compound. It tells us, provided we know the atomic weights of the elements concerned, that is to say, the relative quantity of inertia to which each symbol corresponds, that forty-six grams of ethyl alcohol (for example) correspond to twenty-four grams of carbon, six grams of hydrogen, and sixteen grams of oxygen.†

We think of an atom as something having a fixed and definite weight at a fixed and definite point on the earth's surface, that is to say, as an inertia unit. But it is not sufficient to say that different atoms differ only in respect of quantity of inertia. Otherwise, two atoms of oxygen would be practically the same thing as one atom of sulphur, and so on. We may call this further difference a qualitative difference, but it seems highly probable that in most, if not all, cases, what from the point of view of inertia we call a qualitative difference, from the point of view of energy is a quantitative difference, and reversely. The one atom of sulphur is not the same thing as the two atoms of oxygen, because it corresponds to a different quantity of energy.

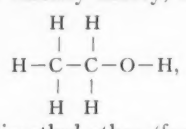
It became apparent in the history of the science, however, that purely atomic or gravimetric formulae

* We use the term "inertia" in preference to "mass" owing to the ambiguity of the latter term. For a discussion of this ambiguity and the consequences to which its non-recognition has led, see the present writer's *Matter, Spirit, and the Cosmos* (Rider, 1910), Ch. 1 "On the Doctrine of the Indestructibility of Matter."

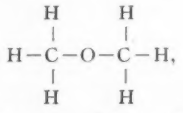
† For the sake of simplicity we use the approximate whole number atomic weights throughout this paper.

XUM

did not adequately represent chemical compounds, and a great advance was made when Franklin introduced and Kekulé developed the theory of valency. The formula of ethyl alcohol, from the standpoint of the valency theory, is written :—



whereas that of dimethyl ether (for example), which is also C_2H_6O, is written :—



It is true that the idea of "bonds" of affinity has been subjected to a certain amount of criticism and even ridicule. It is, of course, quite evident that the dash between the atoms does not represent a hook and eye ; but it does possess a very real meaning. In order to tear apart two atoms which are chemically combined with one another, work must be done. Consequently, a "bond of affinity" corresponds to a certain quantity of energy ; it represents a sort of "energy atom," which is as much an integral part of the compound as the chemical elements of which it is built up. We see, therefore, that the difference between ethyl alcohol and dimethyl ether, for example, may be regarded as an energy difference ; for, although built up of exactly the same atoms, ethyl alcohol contains different "bonds of affinity" from those present in dimethyl ether.

The ordinary constitutional formulae of chemical compounds, therefore, may be regarded as expressing to some extent both the inertia and energy aspects of such compounds, but it is evident that, in these formulae, the stress is laid on the inertia aspect of the body. For instance, the same dash is used to designate different "bonds of affinity" or energy units, although such units differ quantitatively. These formulae indicate primarily the inertia relations of the elements entering into the constitution of the compound in question, whilst the energy relations are implied rather than directly indicated.

It is possible, however, to construct formulae which shall indicate primarily the energy aspect of chemical compounds, the inertia relations being given rather by inference, and, although it is not suggested that these formulae are preferable to the usual constitutional formulae employed at the present day, they may, nevertheless, be found to be not without a certain amount of interest and use.

We do not propose to represent ethyl alcohol, for example, by the formula, 8—, where — represents a "bond of affinity" or energy unit, any more than one would propose to represent it by the formula, say, 9+, where + represents an atom or inertia unit. For the "bonds of affinity" or energy units of which ethyl alcohol, regarded as an energy complex, consists differ amongst themselves both qualitatively and quantitatively—as we have suggested above, this quantitative difference being a qualitative difference from the inertia point of view, and the qualitative difference from the energy standpoint a quantitative difference from that of inertia.

Regarded as an energy complex, ethyl alcohol could be represented by the formula—

$$(C.C)\ (C.H)_5\ (C.O)\ (O.H),$$

dimethyl ether by the formula—

$$(C.H)_6\ (C.O)_2,$$

where C, H, and so on, are not used with their usual significations and do not stand for atoms or inertia units. In these formulae, each complete bracket is to be regarded as a simple symbol standing for a definite and constant energy unit, differing qualitatively and quantitatively from other energy units. The concept of a chemical substance presented by such formulae is that of an energy complex—we are here concentrating our attention, so to speak, upon the "bonds" between the atoms rather than the atoms themselves, the symbol (C.H), for example, representing the "bond of affinity" between a carbon and a hydrogen atom considered apart from the atoms themselves ; (C.C), the "bond" between two carbon atoms ("singly linked"); (C.O), that between a carbon and an oxygen atom ; and (O.H), the "bond" between an oxygen and a hydrogen atom.

By a consideration of such formulae, however, we can deduce the inertia relations of the elements constituting the compounds in question, which are at once given by the usual constitutional formulae. Each energy unit implies a definite quantity of inertia ; in other words it is possible to calculate the molecular weight of any compound by assigning to each energy unit a definite inertia equivalent.

Thus, Mol. wt. of Methane $=16$ $\therefore$ $(C.H)_4 \equiv 16$ $\therefore$ $(C.H) \equiv 4$
Mol. wt. of Ethane $=30$ $\therefore$ $(C.C)+(C.H)_6 \equiv 30$ $\therefore$ $(C.C) \equiv 6$
Mol. wt. of Dimethyl Ether $=46$. $\therefore$ $(C.H)_6+(C.O)_2 \equiv 46$. $\therefore$ $(C.O) \equiv 11$
Mol. wt. of Water $=18$ $\therefore$ $(O.H)_2 \equiv 18$ $\therefore$ $(O.H) \equiv 9$
and so on.

Ethyl alcohol is $(C.C)\ (C.H)_5\ (C.O)\ (O.H)$; therefore Mol. wt. of Ethyl Alcohol equals $6+(4\times 5)+11+9 = 46$, in agreement with that calculated from the ordinary formula.

It is evident that the inertia equivalent of any energy complex $(M.M')$ will be equal to $\frac{m}{v}+\frac{m'}{v'}$, where m, m' are the respective atomic weights of the elements M, M′ and v, v' their respective valencies*

Thus, $(C.H) = \frac{12}{4} + \frac{1}{1} = 4$
$(C.C) = \frac{12}{4} + \frac{12}{4} = 6$
$(C.O) = \frac{12}{2} + \frac{16}{2} = 11$
$(O.H) = \frac{16}{2} + \frac{1}{1} = 9$, and so on, as obtained above.

* In the case of "double" or "treble" links, reckon twice or three times (as the case may be) the equivalent of the corresponding "single" link. Thus,—
Mol. wt. $C\,O_2=44$ $\therefore$ $(C:O)_2 \equiv 44$ $\therefore$ $(C:O) \equiv 22 \equiv 2$ (C.O)
Mol. wt. $C_2H_2=26$ $\therefore$ $(C:C)+(C.H)_2 \equiv 26$ $\therefore$ $(C\ \ C) \equiv 18 \equiv 3$ (C.C), and so on.

A further question, however, arises. The atomic weight of an element is constant in value, no matter into what combinations the element may enter. In other words, no matter with what other symbols it may be combined, the symbol C (say) implies exactly the same quantity of inertia. Does a corresponding law hold in the case of energy? Does the C.H bond, for example, always imply the same quantity of energy? In other words, is the same quantity of heat required to sever this bond in all compounds in which it occurs? May we treat the symbol (C.H) as really representing a definite and constant energy unit?

Now, it has been found possible to determine the actual atomic weights of the elements measured in terms of the atomic weight of one of them as the unit, and, although it is just possible that the atomic weights we are accustomed to use may in reality be multiples or submultiples of the true atomic weights, it cannot be doubted that, in at least the majority of cases, this possibility is a very small one. All lines of evidence go to strengthen the conviction that the majority of the atomic weights now employed are correct within the limits of experimental error.

But it is not possible to determine the quantity of energy bound up within the molecules of chemical bodies. All that can be measured is the quantity of heat absorbed or given out (as the case may be) during a chemical change, *i.e.*, all that can be measured is the difference in energy between a compound and its dissociation products or some isomeric compound, or between two or more compounds and other compounds which result from their interaction; and from the data thus obtained it is not possible to calculate the energy values of the various "affinity bonds." This affords a further reason why gravimetric-chemistry has received more attention and has developed to a higher state of perfection than Thermo-Chemistry.

Nevertheless we are of the opinion that each specific "affinity bond" is equivalent to a definite and constant quantity of energy. For, as we have shown in our monograph *On the Calculation of Thermo-Chemical Constants*, (Arnold, 1909), it is possible, from a sufficient quantity of data, to obtain the values of certain derived constants, each of which may be regarded as the algebraical sum of the energy values of certain "affinity bonds," which constants (with certain exceptions, for which the work referred to above must be consulted) are seen to be constant in value, inasmuch that the molecular heats of formation and combustion of over one hundred various carbon compounds calculated thereby are in quite satisfactory agreement with those obtained experimentally*. It seems a valid conclusion to draw from this fact that the simple "affinity bonds" themselves each correspond to a definite and constant quantity of energy, although indeterminate in the present state of knowledge.

This will probably become clearer by considering a simple case. Take the case of the combustion of hydrocarbons. The general formula for a hydrocarbon being $C_n H_{2(n+1-a-2b-p)}$, where a is the number of ethene links, b the number of ethine links, (the number of ethane links being $n+p-a-b-1$), p a constant depending on the number of rings formed, we have as the general inertia equation for the combustion of hydrocarbons the following,—

$$C_n H_{2(n+1-a-2b-p)} + \tfrac{1}{2}(3n+1-a-2b-p)O_2 = nCO_2 + (n+1-a-2b-p)H_2O$$

Now, if C represents the heat of combustion of a carbon atom, *not* including the influences of its valencies, H the heat of combustion of a hydrogen atom ***plus the specific influence of the link joining it to a carbon atom***, and L_1, L_2, L_3, the specific influences on heat of combustion of the ethane, ethene and ethine links respectively, the molecular heat of combustion of the "general" hydrocarbon is represented by the expression—

$$nC + 2(n+1-a-2b-p)H + (n+p-a-b-1)L_1 + aL_2 + bL_3$$

Now, we have proved, in the work referred to above, that the values of C, H, L_1, L_2 and L_3 are not obtainable in the present state of knowledge. We have also proved, however, that the values of the following derived constants, $C+4H$ $(=\alpha)$, $2H-L_1$ $(=\beta)$, $4H-L_2$ $(=\gamma)$, $6H-L_3$ $(=\delta)$ can be calculated from a sufficient quantity of data, and, using the experimental results of Thomsen, have obtained values for these expressions constant within the limits of experimental error. Substituting $\alpha=C+4H$, $\beta=2H-L_1$, $\gamma=4H-L_2$, $\delta=6H-L_3$ in the above expression for the molecular heat of combustion of the "general" hydrocarbon, we obtain the expression—

$$n\alpha-(n+p-a-b-1)\beta-a\gamma-b\delta$$

for the molecular heat of combustion of any hydrocarbon.

The general energy equation for the combustion of all hydrocarbons is, therefore—

$$(C.H)_{2(n+1-a-2b-p)}\,(C.C)_{(n+p-a-b-1)}\,(C{:}C)_a\,(C{\vdots}C)_b + \tfrac{1}{2}(3n+1-a-2b-p)(O{:}O) = n(C{:}O)_2 + (n+1-a-2b-p)(O{:}H)_2 + n\alpha - (n-p-a-b-1)\beta - a\gamma - b\delta$$

Therefore—

$$2(n+1-a-2b-p)(C.H) + (n+p-a-b-1)(C.C.) + a\,(C{:}C) + b(C{\vdots}C) + \tfrac{1}{2}(3n+1-a-2b-p)(O{:}O) - 2n(C{:}O) - 2(n+1-a-2b-p)(O.H) = n\alpha-(n+p-a-b-1)\beta-a\gamma-b\delta.$$

Therefore, since this equality holds good for all possible values of n, a, b and p, by the laws of identities we have—

(Equating coefficients of n) $2\,(C.H) + (C.C) + \frac{3}{2}\,(O{:}O) - 2\,(C{:}O) - 2\,(O.H) = \alpha-\beta$

(Equating coefficients of p) $-2\,(C.H) + (C.C) - \frac{1}{2}\,(O{:}O) + 2\,(O.H) = -\beta$

(Equating coefficients of a) $-2\,(C.H) - (C.C) + (C{:}C) - \frac{1}{2}\,(O{:}O) + 2\,(O.H) = \beta-\gamma$

(Equating coefficients of b) $-4\,(C.H) + (C.C) + (C\,C) - (O{:}O) + 4\,(O.H) = \beta-\delta$

* We have utilized the results of Thomsen's experiments, which were carried out always under the same conditions.

XUM

Whence—

$4(C.H)+2(O:O)-2(C:O)-4(O.H)=\alpha=210{\cdot}8$ Cals.
$2(C.H)-(C.C)+\frac{1}{2}(O:O)-2(O.H)=\beta=52{\cdot}5$ Cals.
$4(C.H)-(C:C)+(O:O)-4(O.H)=\gamma=89{\cdot}0$ Cals.
$6(C.H)-(C:C)+\frac{3}{2}(O:O)-6(O.H)=\delta=113{\cdot}0$ Cals.*

This represents all the knowledge relative to the energy values of the "affinity bonds" involved in the combustion of the hydrocarbons obtainable by any known means. It is clear that, as we have here four equations involving as many as seven unknowns, the values of these unknowns are indeterminate. A similar set of indeterminate equations will be obtained by considering the molecular heats of formation of hydrocarbons or by considering more complex compounds. Thomsen devised an ingenious method of calculating the energy values of certain "affinity bonds," but as we have pointed out in the Appendix to our work, *On the Calculation of Thermo-Chemical Constants*, the method involves certain unlikely assumptions. We are justified in our statement, therefore, that these values are, in the present state of knowledge, indeterminate. But the values of α, β, γ and δ above, are, as we have already pointed out, constant in value, and the same remark holds good, in general, for the expressions obtained in the cases of heats of formation and of more complex compounds. It seems reasonable to conclude, therefore, that the values of the simple constants from which these are derived are likewise constant; in other words that the energy bound up in the molecule of any chemical body is the sum of the energy values of all the "affinity bonds" within the molecule, which "affinity bonds" each correspond to a specific quantity of energy, constant in value (in general) for each bond; that is to say, that a chemical body may be regarded as a complex of definite energy units.

To sum up: Our object has been to show that the concept of a chemical body as an energy complex is equally as valid as the concept of a chemical body as an inertia complex, i.e., composed of atoms characterized by definite atomic weights, and to deprecate the fact that Thermo-Chemistry, by means of which investigations from this point of view may be carried out, has not received the attention due to it from chemists in general.

THE STERILIZING EFFECTS OF IRONING.

MUCH difficulty is experienced, especially by country physicians, in warranting an efficient prophylaxis against infectious maladies. The main condition to be complied with in this direction consists of protecting the practitioner against the risk of transmitting the disease to the families of other patients and to his own house.

Professor K. Svehla, of the Prague Bohemian University, suggests wearing during the treatment of the patient a special linen cloak left at the patient's house. As, however, such a cloak is only in the beginning free from infection, it should be sterilized between each two successive visits, lest it becomes a focus of infection. As, on the other hand, the usual sterilizing methods (boiling or hot steam treatment) afford with most families serious drawbacks, Professor Svehla, conceived the idea of having these cloaks disinfected by ironing. A series of comprehensive experiments was carried out at the Hygienical Institute of Prague University, the following being the main results:

The flat irons used in connection with these experiments were heated in four different manners—viz., by incandescent iron, charcoal, gas flames, or alcohol lamps. The temperatures of these irons were ascertained by bringing them into contact with the mercury vessel of a thin thermometer wrapt up in a moist linen, and were found to be 219, 220, 238, and 312 degrees Centigrade respectively. Before using any highly heated irons, these were allowed to cool down, and under these conditions the sterilizing effects of the various kinds of iron seem to be equivalent.

The experimenter tested different kinds of linen, cotton, and woollen tissue, fine muslin, cloth, velvet, flannel, and so on; in fact, materials of extremely variable consistency and thickness.

After being infected artificially, these different tissues were submitted to a bacteriological examination during the various stages of ironing—that is, after a single or repeated application of the iron.

A single application of a flat iron on a moistened material infected with any kind of micro-organism was found sufficient to sterilize its surface. Thin materials are sterilized throughout their mass, while in other cases the sterilizing effects are found to decrease with increasing thickness. Any materials of considerable thickness—such as Russian linen as used in manufacturing those cloaks—have accordingly to be treated at least twice on both sides, in order to sterilize not only the surface, but the whole of the mass of the material. In the case of very substantial materials, such as cloth, it is impossible to sterilize the mass by ironing, while in connection with materials of a thickness corresponding to that of Russian cloth the blanket should be ironed before turning the material round.

The experimenter then undertook a series of tests with a view to ascertaining the sterilizing effects exerted on materials too thick to be acted upon throughout their mass, by examining the growth of micro-organisms applied to their surface. Now as these organisms were found not to penetrate into the interior of the material, they can be considered as being likewise sterilized by ironing.

These experiments thus show ironing to constitute an easy and efficient sterilizing process, which is likely to prove of much use in connection with the prophylaxis of infectious maladies.

* These values are from our work on Thermo-chemical Constants to which reference has already been made.

XUM

ANT-EATERS.

By FELIX OSWALD, D.Sc., B.A., F.G.S.

When an animal has become addicted to a special form of diet, the effects are indelibly stamped upon its structure, not merely with regard to its teeth and digestive organs, which are of course directly affected, but in many collateral particulars. The habit of eating grass by camels, deer, cattle, and sheep, necessarily implies a great development of grinding teeth, as well as the differentiation of a many-chambered stomach; the varied forms of hoofs and horns and the habit of grazing in herds are less direct results of a mode of life depending on the nature of the food. On the other hand, the effects of a flesh-diet are even more marked; the canine teeth become adapted into most effective weapons of offence, culminating in the scimitars of the sabre-toothed tiger, now happily extinct, whilst the hind teeth form sharp scissors for cutting and rending the flesh of the victims, and the lower jaw has a special articulation to accentuate the scissor-action so that it can only move up and down. Instead of developing into hoofs, the claws become sharper and more hooked until they reach the high specialisation of the cat-tribe, and are furnished with retractile muscles.

Perhaps the most far-reaching modifications in structure and habits have been brought about by an exclusive diet of ants, or termites. It is, indeed, extraordinary why this habit should, on the whole, exercise a degenerative influence on many points of structure, but the facts clearly show this to be the case among animals of widely distant affinities. In the first place the ant-eating habit can only become exclusively developed in tropical, or sub-tropical, regions where ants are to be found all the year round.

Among Amphibians there are quite a number of toads which have become specialised in this direction. In the Malagasy toad *Rhombophryne* and the Indian *Glyphoglossus* the tongue is increased in length and possesses a longitudinal groove so as to nearly convert it into a double apparatus; its efficiency is also accentuated by a greater freedom of attachment so that it can be protruded further than usual. An additional modification in these forms, and in *Callula*, is the presence of two serrated transverse folds in the palate, which, however, does not possess actual teeth. These ridges, one in front of the vomers, the other just in front of the oesophagus, obviously assist in retaining such active victims as ants, and in preventing their escape. In the Mexican *Rhinophrynus dorsalis*, which feeds on termites, the elongated tongue is free in front so that it can be protruded directly and not by reversion as in other toads.

The shape of the body in these forms is also modified with regard to the exigencies of digging, so as to effect an entrance into ants' nests: shortness of limbs is combined with stoutness of figure and small size of head. In *Rhinophrynus* the short, stout limbs are well adapted for digging, and we find, also, a special modification in a large horny metatarsal tubercle, in shape like a shovel, and possessing the same function. A similar (tarsal) shovel is developed in *Breviceps*, for the same purpose of digging in the nests of termites.

The skeleton in these ant-eating toads has also undergone the modifications necessary for the strain that is put upon it by the habit of digging; the pre-coracoid bars are usually well developed, and the coracoids are perceptibly strengthened. In *Cacopus* and *Glyphoglossus*, however, the pre-coracoids are absent and the coracoids are all the stronger in proportion.

A very general feature which ant-eating toads possess in common is a pointed and prominent snout; this is particularly well developed in *Rhinoderma*, *Phryniscus*, *Calophrynus*, *Stercocyclops*, *Hypopachus*, and *Engystoma*, and projects considerably beyond the upper rim of the mouth and beyond the nostrils. The mouth is also very narrow in *Cacopus*, *Glyphoglossus*, *Breviceps*, *Rhombophryne* and *Hemisus*. All these toads are in the habit of devouring ants and termites, and their teeth are either greatly reduced in number or are altogether absent, as in *Rhinophrynus* and *Myobatrachus*.

It will be noticed that nearly all these modifications are met with again in ant-eating mammals, but they reach a much higher development, so that it may be plausibly conjectured that the ant-eating habit is a more recent acquisition in toads than in these mammals. This suggestion receives some support from the consideration that the latter belong to very ancient orders, being confined to the Monotremes, Marsupials and Edentates.

In the Ant-eating Echidna we find, as a result of its mode of life, a long, narrow snout, powerful digging-claws, and a total absence of teeth. The very long, flexible tongue is provided with an abundant, sticky secretion from the large and well-developed submaxillary glands which extend down to the fore-part of the chest. The ants are also prevented from escaping by the presence of backwardly directed, horny spines on the palate and tongue. The strong fore-limbs are short and stout, and the animal can burrow into sand with astonishing rapidity. The loss of teeth renders it open to the attacks of carnivorous animals; hence it has adopted nocturnal habits in addition to the special defensive protection of strong spines mixed with the hair of the upper part of the body. It has also developed the power of rolling up as a last resource, yet it cannot do this quite so successfully as the hedgehog, to which it presents a somewhat superficial resemblance. This extreme specialisation of the ant-eating Echidna may be regarded as a

XUM

supreme bid for survival on the part of one of the last members of the nearly extinct class of Monotremes, that strange tribe of egg-laying mammals, which display such a striking combination of reptilian characteristics in their structure.

Among the Marsupials of Australia another ant-eating animal is known—the squirrel-like *Myrmecobius*—but here the degradation is not so self-evident, for its diet consists of other insects besides ants; and, so far from being toothless, it enjoys the reputation of possessing more teeth than any other mammal (excepting the Dolphin with its one hundred and sixty to two hundred teeth of a uniform pattern). Its tongue, however, is long, cylindrical and extensible, as in all ant-eating animals; and its strong curved claws are well adapted for digging up the nests of ants, or termites.

Ant-eaters form a considerable section of the existing Edentata, or toothless animals, although this term is not strictly correct. In South America the Great Ant-Bear reaches a great size, considering the nature of its diet, for, as D'Azara has said, "it seems almost incredible that so robust and powerful an animal can procure sufficient sustenance from ants alone; but this circumstance has nothing strange in it to those who are acquainted with the tropical parts of America and who have seen the enormous multitude of these insects, which swarm in all parts of the country to such a degree that their hills often touch one another for miles together." The animal measures about five feet from head to tail, but a good deal of this is accounted for by three feet of bushy tail and fourteen inches of head, mainly consisting of a long, narrow snout. The worm-like tongue can be protruded for about eighteen inches, and, as in all ant-eaters, is amply supplied with a glutinous saliva from highly developed sub-maxillary glands. The fore-feet are well provided with powerful claws for digging into ant-hills, and for defending itself most effectually against dogs and even jaguars. Its flesh has a musky flavour, which is always a deterrent to an animal which has once tried the nauseous experiment. In one respect this Ant-Bear is more highly specialised than any other eater of ants, for the bony palate is lengthened to a degree only to be found in some whales, or in crocodiles. Just as this modification enables the crocodile to breathe whilst drowning its victim, and to keep just the tip of its nostrils above water, so the Ant-Bear is similarly enabled to breathe continuously without interrupting its meal of ants or termites, which it captures with its long, viscid tongue.

The other two ant-eaters of South America are arboreal creatures, and, although toothless, they have not been subject to such extreme modifications as the Ant-Bear, for their diet is not exclusively confined to ants, but includes bees and wasps. Both the Tamandua (*Tamandua tetradactyla*) and the Two-toed Ant-eater (*Cyclothurus didactylus*) possess a prehensile tail, which is better developed in the latter, and is closely correlated with their arboreal and nocturnal habits. The only protection of the Tamandua seems to be its disagreeable odour, which may be detected at a very great distance, particularly when the animal is irritated. The appearance of both these ant-eaters somewhat recalls that of the sloths, and they seem to indicate the intermediate stages by which an arboreal sloth may have gradually developed into the terrestrial and highly specialised Ant-Bear.

In Africa there are ant-eaters belonging to the same order of Edentata, but they are even more strangely modified as a result of their diet. The Cape Ant-eater (*Orycteropus capensis*) is a thick-set creature, with large ears and a pig-like snout, which earns for it the Dutch name Aard-Vark (earth-pig). Unlike the Ant-Bear its fur is extremely scanty, and its only means of defence is its habit of living underground in burrows during the daytime, and only issuing forth at night to attack ants' nests, by digging them up with its powerful claws and liming the insects with its long, viscid tongue. The unnecessary complexity of its stomach, the presence of a caecum, the possession of peculiar back teeth, differing in structure from those of any other animal, and the comparative shortness of its tongue for an ant-eater, are all characteristics that seem to point to the inference that its ancestors must once have been vegetarians. It is not confined to the Cape, but ranges into Senegal and Egypt, and a closely allied species has been found in the Pliocene of Samos and of Persia (Maragha).

The pangolins (*Manis*) of Africa and Southern Asia are the strangest of all the ant-eaters in appearance, for they have become invested with a complete armour of overlapping, flattened scales, and can show a most efficient defence, especially when they roll up on being alarmed, offering nothing but the sharp edges of the scales to the attacks of carnivorous animals, and they possess the additional advantage of nocturnal habits. For the purpose of digging up ants' nests their limbs have powerful claws, which are in some cases forked, and the bones of the hand and wrist are specially strengthened with bony unions, so as to secure greater efficiency and resistance. As in other ant-eaters, teeth are absent, the tongue is wormlike, the salivary glands are large and extensive, but the snout is only moderately developed.

Reptiles furnish only few examples of the ant-eating habit. An archaic form of snake, the Australian Blind Snake (*Typhlops rupelii*), has escaped extinction by taking to living in ants' nests and feeding on the inmates; a corresponding amount of degeneration has taken place, for no teeth are developed in the lower jaw, and its only teeth are restricted to the small transversely placed maxillary bones. The eyes are hidden by skin-shields and are apparently functionless.

Among Lizards the *Amphisbaena*, which has taken to a subterranean habit, with the consequent loss of limbs and even of scales, is frequently found in the nests of ants and termites, although its diet

is not altogether restricted to these insects. The tongue, however, of these worm-like reptiles has become elongated, and is covered with scaly papillae.

Even in birds we find some forms which have taken to the easy and lazy mode of life of ant-eating. The most marked modification due to this cause is the greatly-elongated tongue occurring in the majority of the order of the Woodpeckers, and the correspondingly abnormal development of the hyoid cornua. The ant-eating habit is seen at its best in the Wryneck *(Iynx torquilla)*, which feeds by preference exclusively on ants. Its tail-feathers have not become stiffened for the purpose of climbing trees, as in the Woodpeckers. It is a migratory bird and returns to Africa for the winter months, probably owing to the impossibility of obtaining ants during this period of the year in our comparatively rigorous climate, whilst ants are always omnipresent in the Tropics. Its relative, the Great Green Woodpecker, *(Gecinus viridis)*, also shows a preference for feeding on ants, and commits great ravages in anthills, making able use of its long, extensible and sticky tongue, barbed at its tip. It is more often seen upon the ground than our other two British Woodpeckers. The tail-feathers, however, are strong and spiny, and well adapted for furnishing support in climbing trees. Since the Woodpecker is able to obtain other insects than ants, owing to its tree-haunting proclivities, there is no necessity for it to leave our country on the approach of winter; moreover, it occasionally supplements its insect-diet with nuts and acorns. There are other Woodpeckers which have become still more addicted to vegetarianism, and the Red-headed Woodpecker *(Melanerpes formicivorus)* has been known to make a store of acorns against the winter. It would, therefore, seem probable that the Woodpeckers acquired their long tongues primarily for the purpose of catching ants, and only secondarily became adapted for climbing trees, and boring holes in wood.

In reviewing all these cases of ant-eating animals it is clear that a similar mode of life has brought about a striking similarity of structure between animals widely separated in affinity from one another. Strong digging claws, with the necessary modifications in the pectoral girdle, a long, worm-like tongue with a proportionately lengthened snout to accommodate it when not in use, an excessive development of the salivary glands and the loss of teeth, which have disappeared more or less completely, according to the length of time during which the species has adopted ant-eating habits. This toothless condition, and the difficulty in walking necessitated by the lengthened claws, require fresh methods of defence or protection; hence most of these creatures (excepting birds, which can readily escape by flight) have adopted a nocturnal mode of life; some have acquired an obnoxious odour, others have adopted spines, together with the power of rolling up, but the most perfect adaptation is shown by the pangolins, which can not only roll up, but are completely enswathed in overlapping armour plates. It is curious that the mammalian ant-eaters belong to antique types, which might possibly have become quite extinct long ago, if it had not been for this easy method of obtaining a sustaining and nutritious food. This property is well known in some parts of the world, for instance, in Egypt, where ants mixed with honey are sometimes given to horses to give them greater staying power. Moreover, ant-eating seems to necessitate in animals a higher degree of intelligence than that of their nearest relatives, which have kept to a more normal mode of life, if we may judge from the structure of the brain, which is convoluted in the Ant-eating Echidna, but is smooth in its Monotreme cousin, the Ornithorhynchus. Similarly, the brain of the Great Ant-Bear of South America presents numerous convolutions, and has a large corpus callosum; the anterior commissure is also remarkably large. In their vegetarian cousins, the sloths, on the other hand, the brain is nearly smooth, with a very small corpus callosum.

SOUTH EASTERN UNION OF SCIENTIFIC SOCIETIES.

The Fifteenth Annual Congress of the South Eastern Union of Scientific Societies will be held at Guildford from June 8th to the 11th, 1910, and the President Elect is Professor Ernest A. Gardner, M.A., Yates Professor of Archaeology, University College, London, who will deliver the Annual Address on the evening of the 9th. In addition to the usual delegates' meetings, a series of papers be will read and lectures given. Among these is one on the "Relation of the River Wey to the Blackwater and the Arum," by Mr. Henry Bury, F.G.S., while Mr. Edward A. Martin, F.G.S., will give the results of his investigations on Dewponds. The Pilgrim's Way between Farnham and Aldbury will be discussed by Mr. J. G. N. Clift, the Honorary Secretary of the British Archaeological Association; Mr. A. R. Horwood will deal with "The Extinction of Cryptogamous Plants," and the "Interpretation of Early Maps" is the subject chosen by Dr. W. Martin, M.A., F.S.A. Among the more popular lectures will be one by Mr. J. W. Tutt on "Colour in Insects," and another by Dr. Warre Cornish on "Waves in Sand and Snow," while after the Congress, Mr. Frederick Enock, F.L.S., will give his lecture entitled "Aquatic Autocrats and Fairies." Arrangements have been made for Geological, Archaeological and Botanical Rambles, and invitations have been issued by the Mayor of Guildford and other residents to Receptions and Garden Parties.

Members of affiliated societies are admitted to the Congress on payment of 3/-, and their friends will be allowed to attend at the discretion of the Council of the Union, on payment of 4/-. The present Honorary Secretary of the South Eastern Union of Scientific Societies is the Rev. R. Ashington Bullen, B.A., F.L.S., and his address is Englemoor, Woking.

XUM

CORRESPONDENCE.

GREEN FLOWERS.

To the Editors of "KNOWLEDGE."

SIRS,—Mr. Bulman, in his article in "Knowledge" (April, 1910), tells us that Prof. Plateau has been forcibly led to the conclusion, by his experiments upon the mutual relations of insects and flowers, that the bright colours of flowers, making them conspicuous in contrast to green foliage, do not play the important role in attracting insects which has been attributed to them. One of the interesting arguments which he brings forward in favour of this view is that there are the large number of green or greenish flowers which are visited and fertilized by insects, the results of Prof. Plateau's studies of a familiar green orchid, known in this country as the Twayblade (*Listera ovata*). Growing the plant in pots he was able to place the flowers in the most favourable position for their insect visitors and for making observations upon them.

That many insect-fertilized plants have green flowers is a fact which has not been overlooked from the time when the fertilization of flowers by insects engaged general attention. Grant Allen, in his work upon the Colours of Flowers, published in 1882, refers to British green entomophilous flowers as follows: "Why these highly developed entomophilous blossoms should have found green suit them better than white, pink, or purple, it would be hard to say, but the fact remains undisputed."

Would not Prof. Plateau have been more likely to have arrived at correct conclusions by careful observation of the plants in their natural environment, than by placing plants growing in pots in favourable positions for insect fertilization? That insects do visit green blossoms is well known; the question is in what manner does this green colour favour the plant by attracting insect visitors. One of the smallest entomophilous plants is the moscatel (*Adoxa moschatellina*). This not only has green flowers, but it flowers at a time of the year when flying insects are few, and it secretes honey scantily. Yet, in spite of the small size of this plant and its green colour, it would be difficult to pass by a group of these plants unobserved, their pretty green flowers standing up very conspicuously. Its musky scent is also specially attractive to the Diptera and Hymenoptera, which almost exclusively visit this plant. The explanation is simple. The plant matures at a time of the year when vegetation is scarce, and consequently the bright green foliage and flower of this plant is rendered very conspicuous by contrast with its dull brown surroundings—probably green is at this season of the year the most conspicuous colour. There is little risk of any insect which may happen to come within reach of these plants passing them by without a visit. Probably the explanation of the reason why this entomophilous flower should mature at a season when there are so few insects flying is that at a later period so tender a plant would have little chance of holding its own amid the crush of coarser vegetation. Several of our native plants with green flowers, such as the hellebores, flower early in the year, or grow in situations where vegetation is scant, and their fertilization is favoured both by the green colour rendering them conspicuous and by absence of competition from other plants in their near neighbourhood, which would serve to distract the attention of insects from them.

It is true that the Twayblade, the plant used by Professor Plateau for his experiments, flowers later in the year, and grows not only in woods with scanty vegetation, but also in meadows. Nevertheless its erect habit with its spike of flowers erected above its two horizontal leaves, all standing out well from the surrounding vegetation, renders it a conspicuous plant, not readily passed by without observation, and it is quite possible that it has adapted itself to growing in meadows comparatively recently. In early times meadows were not so abundant in England as in the present day.

On the other hand, a large proportion of our brightly coloured flowers, if deprived of their conspicuous and highly coloured petals would be almost completely lost in the surrounding mass of vegetation.

A difficulty one always feels in attempting to study flowers in their natural environment in a highly cultivated country like England, is that only a few centuries ago many of our wild flowers probably grew in very different environment, and have comparatively recently adapted themselves to their modern situations, for in earlier times our hedge banks were probably few and far between, and woods and wastes formerly greatly exceeded in extent the cultivated area of our land. In some cases the colours and adaptations of plants were evolved when their environment was very different to that in which we now find them. This should make us cautious in making generalizations based upon a few plants possessing characters which do not appear to follow the general law, and do not appear to favour their growth in the situations in which we now find them. Experiments made in gardens often serve to elucidate *details* in the structure and habits of plants, but we should be very cautious in drawing conclusions from such experiments, opposed to well established laws or generalizations based upon a mass of evidence collected by careful observation of wild plants *in their natural environments.*

J. C. SHENSTONE.

THE FALL OF A METEORITE.

To the Editors of "KNOWLEDGE."

SIRS,—A large meteorite fell in Bombay Harbour at 4.15 p.m. (standard time) on the 25th of April. The explosion was heard for miles round. To me, personally, it sounded like a blasting operation, followed by a dull vibrating echo that took forty to fifty seconds dying away in the distance.

A friend of mine was fortunate enough to witness the actual fall of the meteor. To him it appeared like a white-hot ball of some 3′ to 4′ in diameter, and as it rushed through the air, a distinct vapoury tail was left, white-hot to red around the nucleus, shading off to yellow and then blue. On striking the surface of the harbour, the meteor threw up a high column of water with steam, like that produced by a shell from some big gun.

One witness writing in the "*Times of India*," describes the phenomenon as: "A ball of fire accompanied by a vertical semi-disc above it of intensely brilliant white light . . . . the diameter 8″ to 9″, followed by a streak of smoke." Another writes, he saw "a flash in the sky and a large ball of fire about six to eight times the size of the evening star (?), leaving a streak of white vapour." Neither of these observers saw the actual fall in the harbour.

The following further reports from hill stations in the Western Ghauts may also be of interest.

Khandalla.—"A terrific report, heard at 4.15 p.m., proceeding from the direction of Poona, followed by a loud and continued vibration. . . . . A rumbling noise from N.E., followed by a loud explosion, and a volume of snow-white smoke which travelled high up in space across the sky, leaving a trail. . . . . Sounded like a huge motor car in the air."

Matheran.—"A bright flash in the sky, at 4.15 p.m., followed by a report lasting several seconds. . . . Smoke seen as well."

Mableshwar.—"A flash and report that passed over the hill."

From the foregoing description it is evident the meteor was of considerable size, and its general direction from the S.E. The 25th inst. was a bright hot-weather afternoon.

Was our visitor a LYRID?

I am, yours truly,

C. F. DOBBS, *Capt.*,
Brigade-Major, Bombay.

11, QUEEN'S ROAD,
BOMBAY,
30th April, 1910.

THE CRATER OF THE MOON.

To the Editors of "KNOWLEDGE."

SIRS,—Referring to page 192 of the last number of "KNOWLEDGE," would you be so good as to let me know in what book or article in the papers does Professor T. J. J. See announce his theory that "the origin of the so-called Craters on the surface of the Moon is not volcanic, but due to the impact of bodies, which he calls satellites." I, for one (see my letter, page 26 of "KNOWLEDGE," Jan. 1909), agree with the Professor, and not with your correspondent when he states "that most Astronomers and Geologists will maintain their adherence to the volcanic, rather than the impact, theory."

Yours truly,

BALLYRANE, H. L. MEADOWS.

KILLINICK, CO. WEXFORD.

16th May, 1910.

THE SHUNT RELAY.

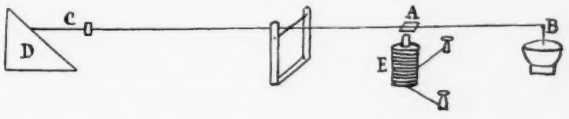
By CHARLES E. BENHAM.

IN using a sensitive galvanometer it is often necessary to interpose a shunt. By this means the circuit of the main current is subdivided so that only a small portion passes through the galvanometer, the delicacy of which would render it liable to injury if the full current were passed through. The ratio of the current through the divided circuit to the main current is a simple matter of proportion, the respective resistances being known. Thus, if the resistance of a shunt is $\frac{1}{n}$th of the resistance of the galvanometer, the total current in the main circuit is $n + 1$ times the current measured by the galvanometer, and the number $n + 1$ is called the "multiplying power of the shunt."

A somewhat similar application of the principle to a relay affords some interesting results, not without possible practical use. If a house is furnished with an electric bell that is earthed to the gas main, it will be found that whenever the bell rings a minute current travels along a wire, even in a distant part of the house, connected simply with the gas pipe at one end and the water main at the other. The resistance of the water pipe is so much less than that of the gas pipe that a certain portion of the current from the bell circuit will travel to it, even through the roundabout course provided by the above arrangement. A sensitive galvanometer interposed in the wire loop leading from gas to water pipe will be strongly deflected whenever the bell is rung, although there is no apparent connection. The current will also be sufficiently strong to work a relay, and thus a second bell may be made to ring responsively to the door bell, even at a distant part of the house, without any communication between the two circuits except that both are in connection with the gas pipes.

The relay must be of a sensitive character, but its construction is so simple that any amateur can easily make it. A light brass wire, about seven inches long, is pivoted as shown in the illustration, so that it swings on brass bearings. A small piece of very thin soft iron is soldered to the wire at A, and a pin projects downwards at the end B. A cork counterpoise, C, near to the other end of the wire, is adjusted so that the end C is slightly the heavier. A triangular wedge of smooth wood supports that end and is pushed up until the armature A almost touches the core of the electro-magnet E, which has three or four windings of thin covered wire, joined up to the terminals of the instrument. Under B is a small vessel of mercury raised to such a height that the point of the pin nearly touches the surface of the mercury. A very minute current through the coil will suffice to make it dip into the mercury by the attraction of the armature to the core of the magnet. The bell and battery circuit wires (belonging to the relay) are attached, one to the brass support of the pivot, the other to the mercury, and it will be realised that whenever the pin dips into the vessel the circuit will be completed and the bell will ring. The wires from the gas pipe and water main are attached to the terminals of the relay, and it is interesting to see its prompt response to the door bell in another part of the premises, with no other connections than those just described.

It should be mentioned that the experiment



cannot well be carried out in a house where there are closely adjacent electric tramways or railways. Under such circumstances the current produced between the gas and water pipes by leakage from the traction system causes a more or less continuous current in the relay coil, which has only to be switched on to set the relay working and its bell ringing, and, though in this case the practical utility of the device for obtaining a responsive signal to the ringing of the house bell is not available, the experiment is interesting as demonstrating the lavish profusion with which the electric supply companies scatter their electricity about. The tramway leakage current, by the way, will most likely be found to be in the direction from the water main to the gas pipe.

Other applications of the principle will no doubt suggest themselves to those who are sufficiently interested to make the experiment. The chief point to bear in mind in the construction of the relay is the necessity for lightness in the lever. The mere compensation of its weight by a counterpoise does not come to the same thing, as it involves increased friction at the bearings and consequently more inertia to be overcome.

XUM

REVIEWS OF BOOKS.

SOME EGYPTIAN LITERATURE.

The Book of the Dead.—An English translation of the Chapters, Hymns, etc., of the Theban Recension, with introduction and notes.—By E. A. WALLIS BUDGE, M.A., Litt. D. Second edition.
(Kegan Paul, Trench, Trübner & Co. Three vols. Price 15/- net.)

The Book of the Opening of the Mouth.—Egyptian texts, with English translations.—By E. A. WALLIS BUDGE, M.A., Litt. D.
(Kegan Paul, Trench, Trübner & Co. Two vols. Price 12/- net.)

The Liturgy of Funerary Offerings.—Egyptian texts with English translations.—By E. A. WALLIS BUDGE, M.A., Litt. D.
(Kegan Paul, Trench, Trübner & Co. One vol. Price 6/- net.)

The Light of Egypt.—From recently discovered Predynastic and early Christian Records, with fifty-seven plates.—By ROBERT DE RUSTAFJAELL, F.R.G.S.
(Kegan Paul, Trench, Trübner & Co., 10/6 net.)

English readers owe a profound debt of gratitude to Dr. Wallis Budge, who has revealed to them the beauty and mystery of so much Egyptian literature, opening the sealed books of ancient religious rituals, and expounding the strange and elaborate ceremonies that accompanied, or were connected with the rites of burial. As Dr. Budge explained in an earlier book on "The Egyptian Heaven and Hell," many ancient peoples held very definite beliefs about the life after death, but none other created an elaborate liturgy describing the future existence of the soul, and copiously illustrating their writings with pictures of the gods and devils that it would encounter on its journey through the world beyond the grave. The "Books of the Dead," as they were called, were, in effect, a sort of illustrated guide to the other world, inscribed on tombs and coffins, for the benefit of the dead in the life to come. The translations in these volumes are a representative collection of such compositions, taken from papyri and other documents found chiefly at Thebes, and known as the Theban Recension, or review of the national funeral work, which was copied by the Scribes for all classes, from king to peasant, between 1600 B.C. and 900 B.C., and "The pious Egyptian, whether king or ploughman, queen or maid-servant, lived with the teaching of the Book of the Dead before his eyes, and was buried according to its directions, and based his hope of everlasting life and happiness upon the efficacy of its hymns and prayers and words of power." Through its directions he would attain to the fertile flat Elysian fields intersected by canals, regain the companionship of his parents and his wife, eat of the fruit of his fields, and sail in his boat catching worms and serpents. But first the deceased had to pass through the Hall of Judgement. A beautifully-executed coloured reproduction represents the scene in which the dead appear before Osiris on his throne, and judgment is meted out to them—annihilation or everlasting bliss—when their heart is weighed in the balance. The whole scene forms a most curious analogy to the familiar representation of the Last Judgement on the mediaeval portals of French churches, in which Christ presides on His throne, surrounded by the hierarchy of Heaven, for the "Three Companies of the Gods," the Archangel Michael weighs the souls of the dead in scales as the heart is weighed by Anubis, while the waiting beast "The Eater of the Dead," corresponds to the jaws of hell, often represented as Leviathan with yawning mouth to swallow the damned.

"*The Book of the Opening of the Mouth*" describes ceremonies used for restoring to the body of the dead man his "heart-soul" and his "double," while the spirit-soul took flight at the moment of death, but these others remained near the body and had to be provided with food and housed. The recital of "The Book of the Opening of the Mouth" recreated the body, and permitted these immaterial elements to continue their existence. The ceremonies were, in later times, performed on a statue by the Chief Priest. Offerings of the hearts of bulls (incarnations of Osiris) were presented to the statue on the spirits of these offerings the heart-souls regaled themselves, while, at the same time, they formed a funeral feast for the priests and the mourners, who thus entered into communion with the other world, for Osiris was at the same time, the victim, deliverer and food of the dead and the living.

"*The Liturgy of Funerary Offerings*" deals exclusively with the presentation of the offerings to the dead. It is associated with the "Book of the Opening of the Mouth," and Dr. Budge suggests that it is supplementary to it. When the double had been housed in a statue it was necessary that it should be provided with food. The formula used in the Liturgy transmuted these offerings into spiritual food, that was partaken of by the dead and by the gods, so that some kind of written service must have been in regular use. Dr. Budge is of opinion that the "Liturgy of Funerary Offerings" was that said for kings or persons of high rank; it comprises one hundred and fourteen ceremonies.

"*The Light of Egypt*" is the title given by Mr. Rustafjaell to an account of his acquisition of some Egyptian manuscripts, seven Coptic volumes, comprising a Greek codex of vellum, and a dozen Greek papyri, all of which were subsequently bought by the British Museum. The author prefixes some translations of the manuscripts with a remarkably comprehensive account of the history, art and civilisation of Egypt, including brief accounts of Moses, Solon, and Zoroaster. The most interesting and curious of the translations is that of the Coptic Manuscript of the Apostle Bartholomew's narrative of Christ's descent into hell. Beautifully reproduced photographs of the original documents add greatly to the interest of the book.

PHYSICS.

Practical Electrical Engineering for Elementary Students.—By W. S. IBBETSON, B.Sc., A.M.I.E.E, 7½-ins. by 5¼-ins., xii + 155 pages.
(E. & F. Spon, Ltd., 3/6 net.)

The title of this little book is well chosen. It covers a series of experiments, divided under five headings, each to prove a definite principle. The diagrams and tables are well executed, and placed before the student in a clear and concise manner. The work should prove of great value to those commencing a course of elementary studies in Electrical Engineering. The author, Mr. W. S. Ibbetson, has been assisted in the preparation of the text by Mr. W. Baker, M.Sc. and Mr. J. Paley, F.Ph.S., and Mr. W. G. Jackson is responsible for the diagrams used in the book.

NATURE STUDY.

A Bush Calendar.—By AMY E. MACK (MRS. LAUNCELOT HARRISON). 6-in. × 7-in., 110 pages, 42 illustrations from Nature.
(Sydney, Angus & Robertson, London, Australian Book Company. Price 3/6 net.)

This little book consists of chapters under the heading of each month, written by a keen observer, on what is to be seen in the "bush" during the period included. For each month also is given a list of the flowers that are blooming and the birds that are breeding, together with names of the migrant birds which are arriving or departing, and the fruits that are to be found. It is, of course, an interesting change to read about birds and flowers which are different from our own in England, and we have to bear in mind the differences in the seasons on the other side of the globe, but perhaps most striking of all is the fact that in every month some bird is found to breed, though in May there is only one name given, that of the Lyre Bird (*Menura superba*). It would be interesting to know how many of these birds are left, for we have been given to understand that the raid on their feathers has been so great that they are very nearly extinct.

The book will appeal to all lovers of out-door natural history and we may say without fear of contradiction the illustrations are by no means the least interesting part of it.

Battersea Park as a Centre for Nature Study.—By WALTER JOHNSON, F.G.S., 4¾-in.×6-in., 128 pages, 1 Map.

(T. Fisher Unwin. Price 1/- net.)

It is an eloquent sign of the times that Mr. Walter Johnson's suggestions for Nature Study in a London Park have been brought out under the auspices of the Battersea and Wandsworth Educational Council. How much is artificial and how much natural in the enclosure concerned, those who read the book will find, though sometimes it is not always those tracts of land which have had most done to them that look the least natural. In any case, however, the birds and plants are alive and they are out of doors, though some of the former may be in aviaries, and many of them are introduced.

At the same time Battersea Park has always been celebrated for the birds that come there of their own free will, and it was this park that was chosen for the experiments that were made some years ago with a view to introducing butterflies. A useful addition to the book is the list of suggestions for rambles, and the natural history calendar, which is applicable to London.

As showing what can be done in the way of studying Nature in London, Mr. Walter Johnson's book should prove most valuable.

The Country Home.—Volume V. Numbers 2 and 3. May and June, 1910.

(The Sphere and Tatler Limited. Price 6d. each, net).

The Country Home deals with all matters connected with the country, and necessarily it includes a certain amount of Science as applied to the cultivation of plants, and some special articles on Natural History pure and simple. In the May number, for instance, there is an exceedingly well-illustrated article by the Editor on Mr. Anthony Wingfield's Menagerie, at Ampthill. In the collection are a number of animals which can "eat hay, and can be trained to carry a rider" and to these Mr. Wingfield confines his attention. The illustrations show keepers riding on Ostriches, Zebras, Llamas, Camels, Guanacos and Zebus, among the foreign animals, as well as on Donkeys of all sizes and kinds, and it may be added, incidentally, that Mr. Wingfield is interesting himself in the improvement of these somewhat neglected animals. It has been their owner's custom for years to train his bulls to be ridden in order to keep them in condition and some rather amusing results have been obtained by breaking in sheep and pigs.

The same number contains a contribution under the heading of "The Natural History of the Garden," from the pen of Mr. Wilfred Mark Webb, F.L.S., which forms an introduction to the study of Earth-worms, and in the June number the same writer deals with Woodlice, to which he and his collaborator, Mr. Charles Sillem, F.L.S., have paid considerable attention. An interesting point brought out is the way in which a series of species can be arranged to illustrate the rolling up of the animal and the protection of its antennae. *Cylisticus convexus* has long antennae and unmodified tail appendages, and cannot quite form a complete sphere. Its antennae, as shown in the illustration which we reproduce (on page 237) by kind permission of *The Country Home*, are turned back over its head. In *Armadillidium nasatum*, one of the Pill Woodlice, the tail appendages are modified, but the antennae are still unprotected. In *Armadillidium vulgare*, a commoner form provision has been made for them to be enclosed when the animal rolls up. We are sure that all our readers who love the country will appreciate *The Country Home*.

Cylisticus convexus *Armadillidium nasatum* *Armadillidium vulgare.*

Woodlice shown extended and rolled up to illustrate the power of forming a complete ball and the way in which the antennae are ultimately hidden and protected.

(*After Webb and Sillem.* By the courtesy of *The Country Home*).

Eton Nature Study and Observational Lessons.—By MATTHEW DAVENPORT HILL, M.A., F.Z.S. and WILFRED MARK WEBB, F.L.S., with a foreword by the REV. EDMUND WARRE, D.D., M.V.O. Parts 1 and 2, in one volume, 8¼-ins.×6¾-ins., xxxiv+329 pages, with Frontispiece and 255 figures.

(Duckworth & Company. Price 6/- net).

Eton Nature Study has now been issued in one volume, and the new edition will be welcomed as being attractive, handy and convenient.

XUM

The book teems with suggestions. It is written for the serious Nature student who enjoys procuring his information for himself. It may not appeal to those who are content to accept facts second-hand, and who prefer to be saved the trouble of making observations for themselves.

Almost every branch of Nature Study work is touched upon, and helpful advice given as to the best way of carrying out a system of teaching which is the only truly educational method.

As stated in the author's preface, the work has a two-fold object—first, to provide a series of observational lessons which may be carried on as part of the school curriculum, and, secondly, to suggest as many lines as is possible of work to be done out-of-doors. To anyone who conscientiously follows one or more of these suggested lines Nature can never be found boring, or the country dull.

In the foreword Doctor Warre, the Provost of Eton, says: "I believe that the book is sound in its method and that it will not only help to train the minds of those who use it intelligently, but also lead the way to that further study of Nature upon right principles which, as time goes on, affords for so many a solace and delight amid the 'sick hurry' and pressure of modern life."

When it is considered how greatly a knowledge of Nature adds to the joy of life, it is small wonder if this interesting book is thoroughly appreciated, and its appearance in the present attractive volume welcomed by teachers and students alike. The references to recognized scientific works in the various chapters are given as a help to those who wish to take up a subject more deeply.

The photograph of a wild cat and her kittens at the beginning of this number was taken to form the frontispiece of "Eton Nature Study," and the photographs and drawings throughout the book are excellent.

Contributions from the Bureau of British Marine Biology.—Series 2, No. 1. A Bibliography and Review of recent Publications relating to the Biology of the British and neighbouring Marine Areas, (*i.e.*, of the North Atlantic and Arctic Oceans, Mediterranean Sea, and so on.) No. 1. Prepared by S. PACE and R. M. PACE.

(The Bureau of British Marine Biology, To Non-Subscribers 2/ net.)

This is part 1 of the Bibliography and Review of Recent Publications, which is published every few weeks, in parts, and is at present only being undertaken as an experiment which cannot be proceeded with unless adequate support to meet the cost of printing is ensured at an early date. The subscription at present is 30/- for twenty parts, but as the Bureau does not wish to make any profit out of the sale of its publications the subscription rate may be reduced as the circulation increases. The following account will show that the scope of the Bibliography is fairly comprehensive. "The bibliographic work conducted by the Bureau of British Marine Biology, although directed primarily to the recording of observations affecting the British marine area, takes account also of all publications (other than purely morphological ones) which have any bearing at all upon the biology of the European seas; and even these wide geographical limits are interpreted in a very liberal manner so as to include practically the whole of the North Atlantic and Arctic Oceans and the Mediterranean Sea. Then, again, every taxonomic group of both the animal and vegetable kingdoms is considered; and, in addition to the strictly marine and living representatives of each group, brackish water forms and occasional migrants and visitors to the sea, and fossils from the Quarternary and Younger Tertiary formations are also dealt with. Considerable attention is further devoted to the recording of such works on Oceanography and on Biological Technique as are likely to be of interest to the marine biologist. The analysis of the works indexed by the Bureau is carried out in extreme detail: a separate entry, for instance, being made for practially every mention of a species."

The title entries will be published as soon as possible, generally within a few weeks after the appearance of a work to which reference is made, and, as a general rule, each entry will be accompanied by a short summary of the work reviewed. Among the subjects in preparation, and which in each case will be published group by group (some groups being already practically complete), may be particularly mentioned: (a) a revised catalogue of the fauna and flora, accompanied by critical and other notes and furnishing references to the best figures and descriptions of each form; (b) an alphabetical index, with full references to original descriptions and particulars of type-localities, etc., of the specific and varietal names which have at any time been used for supposed members of the biota.

NOTICES.

STATUS PRIZE.

We have been requested by the Secretary of the Society of Engineers (Incorporated), 17, Victoria Street, S.W., to remind our readers that the last date on which essays in competition for the Status Prize can be received is Tuesday, May 31st, 1910.

CATALOGUES.

Catalogue B of Microscope Accessories issued by Messrs. Flatters & Garnett, Limited, has reached us. It contains a number of new items, and of these we may especially mention the Copper Water Bath of a new pattern, for glycerine jelly mounting, which is figured on page 41. A new form of Slide Cabinet may also be noticed and the varied series of Dissecting Instruments. Collecting apparatus is now dealt with in a separate catalogue which will be sent free to any reader of KNOWLEDGE.

We are pleased to mention a new Photo-micrographic Apparatus which Messrs. Ross, Ltd., have put on the market. It gives practically unlimited range of magnification and can be used with both transmitted and incident light.

From Messrs. J. H. Dallmeyer & Company's catalogue we learn that they have introduced a new series of Stigmatic Lenses for photography, working at f. 6·3. Their Telephoto Lens has been improved and its use simplified by the introduction of a calculator, while a new mount for their portrait lenses has been patented, which allows of these being more easily cleaned and makes them lighter and less affected by the atmosphere.

We hear from Messrs. The Bausch and Lomb Optical Company, that they have just received a new model of the Stormer Viscosimeter. The simplicity of the machine and the smallness of the sample (55 c.c.) of oil that is needed for the test are the special points of the machine.

At the same time we acknowledge the receipt from this firm of catalogues dealing with Microscopes, Microtomes, and Apparatus of all kinds for use in Photo-micrography.

PARENTS' NATIONAL EDUCATIONAL UNION.

The fourteenth annual Conference will be held this year at London University College, from July 11th to the 14th. A great many subjects of importance in the education of children will be discussed. Among the Chairmen will be Lord Reay, Sir Robert Morant, Sir Victor Horsley, and Dr. Gregory Foster. Season tickets admitting to all meetings will cost 3s. 6d. if bought before the Conference, and they may be obtained from the Secretary, Miss Parish, 2, Victoria Street, London, S.W.

THE WOMEN'S CONGRESS AT THE JAPAN-BRITISH EXHIBITION.

As part of the programme of the Women's Congress at the Japan-British Exhibition, the Hon. Frances Wolseley, Principal of the Glynde School for Lady Gardeners, in Sussex, is arranging a programme dealing with women's work in agriculture and horticulture. Viscountess Falmouth will preside on July 5th, and Nature Study will be one of the matters discussed.

XUM

A BELGIAN VIEW OF ENGLISH PALEOLITHS.

By W. G. CLARKE

(Honorary Secretary of the Prehistoric Society of East Anglia).

In continuation of his series of articles on Prehistoric Man in England, in the bulletin of the "Comptoir Ethnographique de Belgique," "A.R." (obviously M. A. Rutot of the Royal Museum of Natural History at Brussels), having co-ordinated the eolith-yielding beds of this country with the classification of continental archaeologists, briefly proceeds to deal with the Paleolithic Age in England. In the course of his article, which I have freely translated, he says that Great Britain and Ireland having been united to the continent of Europe throughout the quaternary period, we do not expect to recognise any wide differences between the quaternary industries of the two regions. In effect, that is what is found to be the case; at the same time Paleolithic man was not distributed so uniformly in England as in France, for the principal centre of the Lower Paleolithic culture is the South-East of England, while the Upper Paleolithic is everywhere poorly represented.

The Lower Paleolithic implements are found almost exclusively in the ancient deposits of the water courses and are divided into two types, superimposed as in Belgium and the north of France. At first, towards the bottom, an industrial group is found intimately connected with the gravel of the middle terrace of the valleys, and comprising the Strépyien, Chelléen, and lower Acheuléen; next comes the upper level implements, contained in some clayey beds which were only deposited in the upper Acheuléen period. The Lower Paleolithic group is richly represented in Dorsetshire, Hampshire, Sussex, Surrey, Kent, Suffolk and Norfolk; and the valley of the Thames, along the whole length of the right bank, presents admirable sites, showing great analogies with those of the valley of the Somme (Abbeville and Amiens). Unhappily, in the greater part of the beds the stratification is bad, and the Strépyien, Chelléen, and lower Acheuléen industries are intermixed.

There exists below London, on the side of the Thames valley above Northfleet, a series of beds in which splendid discoveries have been made, and several enthusiastic investigators have obtained magnificent collections. One thing which differentiates these beds from those of Belgium is that in the latter country all the older paleoliths are found on the low terrace of the valleys, and the same is the case in the valleys of the Seine and its tributaries. Around Amiens, from Montières on the one hand to St. Acheul on the other, the older Paleolithic industries are all found on the lower and on the middle terrace, but in the valley of the Thames, at the end of the Eolithic period, the primitive inhabitants occupied the low terrace, and Paleolithic man, in order to find shelter from the great and persistent floods, had to reside on the middle terrace, and even then was sometimes compelled to retreat precipitately, the middle terrace itself having been covered with flood-water on various occasions. These were the floods, rising above the middle terrace, which, little by little, mixed up the different industries, the implements of which were previously deposited separately, and this is réndered very evident by the state of the implements constituting the three representative industries. All the pieces with rudimentary chipping, corresponding to the Strépyien, show numerous traces of wear along the arètes; chipped pieces, with fine chipping of the Chelléen period show less pronounced wear; and, lastly, the carefully-manufactured pieces of the lower Acheuléen are more often quite perfect, or simply polished by the friction of the gravel-charged water.

The richest of the beds of the Thames Valley, below London, are Milton Street, situated near Swanscombe, and Galley Hill; and above, the neighbourhood of Reading is very rich, and more than two thousand "*coups de poing*" have been found there. Some pretty almond-shaped pieces have also occasionally been found along the shore of the Isle of Sheppey; they have been partially bleached by the waves, and were derived from some lumps of pebbly earth which fell from the top of the small cliff.

The upper Acheuléen implements are rarely found in the gravels; they come from some clay-beds utilised as brick-earth, resting to the North of London, on the basal moraine of the "Rissien" glaciation. This moraine is generally known as the Chalky Boulder Clay, which covers large areas with a more or less thick mantle. The surface of the clay, with glacial boulders, is covered with depressions, traces of ancient shallow valleys, in which have been accumulated deposits of gravel and peat. The best-known of these beds is at Hoxne (Suffolk), where the following strata have been noted:—

1. Brick-earth, with fresh-water shells and a layer of Paleolithic flint implements.
2. Gravel and chalky clay.
3. Black clay, with impressions of leaves (Arctic flora).
4. Lignite, with plants (Temperate flora).
5. Clay.
6. Chalky boulder clay.

With the Paleolithic implements, which are of the type of the top of the middle gravels of St. Acheul, have been discovered bones of the mammoth, horse, ox, and deer. The beds of Hitchin and Ipswich are situated in a similar stratigraphical position to that of Hoxne.

It now remains to speak of the Upper Paleolithic implements, corresponding with the period of the habitation of caves. These caverns are fairly numerous; they exist in Devonshire, Herefordshire, Derbyshire, and Wales. Among those of Devonshire, Kent's Cavern, near Torquay, is the best known, and has been explored on several occasions since 1824. These explorations, practically in an epoch in which nothing was yet known, were very badly made; the cavern was, however, very interesting, for it certainly exhibited several strata, of which the surface one had implements of the Neolithic and of the Metal Ages, while under the stalactite were others of the Paleolithic Age. It seems probable that the lowest bed is of the Monsterien or lower Aurignacien period, with almond-shaped implements; next there is one of the upper Aurignacien period; and then, uppermost, a bed of the lower Magdalénien, with harpoons and needles of the type of "La Madeleine," with borers and other instruments of bone. The fauna found have been the mammoth, *Rhinoceros tichorhinus*, reindeer, and so on.

The second cavern in the neighbourhood of Torquay is that of Brixham, where fewer almond-shaped implements have been found, and the whole appears more closely to correspond with the middle Aurignacien; instruments in bone were absent, only a fragment of a cylindrical ivory rod having been discovered.

Another English cave is known as Hyena's Hole, at Wookey, near Wells, where have been found split bones and some chipped almond-shaped flints. It is not improbable that the temporary occupation of this cavern dates from the upper Acheuléen period.

The other caverns, scattered in different districts, provide less of importance; the implements are of Mousterian forms, but probably correspond to the Aurignacien, and are sometimes accompanied by fragments of worked bone. The faunal remains are almost always those of the mammoth. It is, however, necessary to make an exception of some caves on the north-east border of Derbyshire, near Cresswell Crags, where some interesting finds have been made. The exploration of Robin Hood's Cave has caused the existence to be recognised of at least three strata, of which the lowest appears extremely ancient, for it includes some pebbles of quartzite chipped to form primitive "*coups de poing*." A little higher there seems to have been a bed of upper Aurignacien age surmounted by one of lower Solutréen. These beds have also yielded an engraved bone representing a horse's head. From Church Hole Cave has been obtained a beautiful needle with pierced eye, of Magdalénien type; and Mother Grundy's Parlour has furnished, at its base, a bone-bed with remains of the hippopotamus and *Rhinoceros merkii*.

In conclusion it may be stated that England, viewed in relation to the Paleolithic period, both upper and lower, does not differ materially from France and Belgium.

XUM

MICROSCOPY.

As Microscopy is the hand-maiden to very many branches of Science, it is difficult for one worker to deal with the whole subject, and a suggestion has been followed that a number of those who use the microscope in their studies should be responsible for the microscopical column in KNOWLEDGE. We have pleasure in announcing that the well-known microscopists whose names are given at its head have already promised to help.

ARTHUR C. BANFIELD.
JAMES C. BURTON.
THE REV. E. W. BOWELL, M.A.
NICHOLAS E. BROWN.
CHARLES H. CAFFYN.
ARTHUR EARLAND.
C. D. SOAR, F.R.M.S.
RICHARD T. LEWIS, F.R.M.S.
CHARLES F. ROUSSELET, F.R.M.S.
D. J. SCOURFIELD, F.R.M.S.

THE SIMPLE MICROSCOPE.—Under some circumstances it may be desirable to use a simple microscope for purposes of observation, as well as in the work of preparing objects. The stands that are now sold, consisting of a stage and pillar containing rackwork adjustment for the ring in which the magnifier is made to fit, are generally much more business-like constructions than the simple microscopes of fifty years ago. There is, however, one thing lacking in all the types which I have seen; no provision is made for a condenser. The idea that the efficiency of a pocket-lens may be improved by the use of a condenser will perhaps astonish some practical workers, but will be amply justified by experiment. In examining the chitinous structures of insects with the compound microscope, using a good two-inch objective, I had repeatedly noticed that "critical illumination" is almost as important as with high powers. In this case the condenser is not required for the elementary purpose of giving more light, but in order to ensure sharp definition of outlines. Employing, therefore, an Abbe condenser, and focussing upon the object the image of a tract of illuminated sky, then closing the iris to the requisite extent (ascertained by inspection of the back lens of the objective), I get from the two-inch about as much information concerning the details of the object as is yielded by a one-inch of corresponding quality and aperture without the condenser. The field being roughly twice the size, a real advantage is gained. I have tried the method usually recommended, of using a lens, achromatic or otherwise, of longer working distance than the Abbe condenser, and focussing the image of the radiant upon the objective front. After numerous trials I came to the conclusion that the image ought really to be focussed upon the plane of the diaphragm between the two components of the objective, rather than upon the front lens; the effect when this is done is distinctly better. Perhaps the instruction to focus on the front lens refers to the old-fashioned type of low-power objective, which was often only a single achromatic combination. This method of arranging the illumination I find very good when a maximum of brightness in the image is required, i.e., for photography or screen projection. But otherwise it is by no means equal to the plan described above, of using an ordinary condenser and an extended source of light, focussing this on the plane of the object. Since it is a practical advantage to be able to recognise the character of small structures, such as radulae, tracheal tubes, or the striae on insect scales, with the *lowest* possible magnification in the first instance, I now always use a condenser, even for dissecting. Since it is often desired to record some particular phase of an object by photography, and the aberrations of an ordinary chromatic condenser have a way of appearing on the photographic plate when least expected, I chose an English achromatic condenser for the purpose, and experience has certainly made me value it more than I anticipated. The top can be removed, leaving an achromatic combination of longer focus, most useful for photography with the lowest powers, the image of the radiant being still focussed on the object. After this experience with low powers and the compound dissecting microscope, it happened that I wished to select the most efficient type of simple microscope, capable of being included in the portmanteau of a friend who was going abroad. The stand has a good firm stage and attachable handrests, and a rack and pinion adjustment for the magnifier. Two magnifiers were chosen; a Steinheil of ten diameters, and an anastigmat of twenty-seven. It is of course evident that if a higher magnification were required the Steinheil could be employed as ocular to the anastigmat, thus producing a temporary compound microscope. For this purpose it is by no means essential to have a tube, provided one holds the ocular lens steadily over the optic axis. For greater convenience, however, a simple tube fitting was devised. It then became apparent that the medium power magnification thus obtained, which is extremely good and clear, would be still further improved by the addition of a condenser. A sliding understage fitting was therefore added, arranged to take an Abbe condenser provided with its own iris diaphragm. The adapted ocular tube had

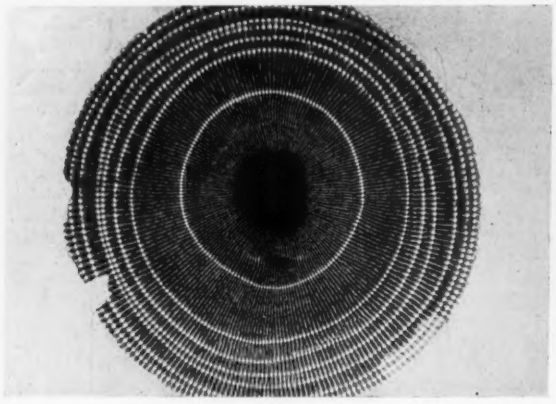


FIGURE 1.

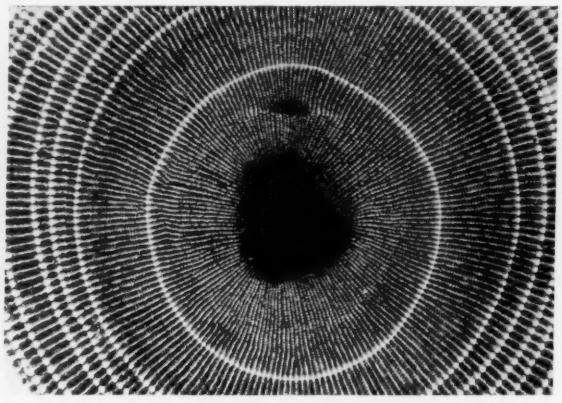


FIGURE 2.

Photo-micrographs of an Echinus spine seen in section, taken with a simple microscope, namely a ten-diameter Steinheil.

been contrived so as to allow of a certain amount of adjustment for centering. A very portable and efficient instrument was thus produced, only lacking a fine adjustment. But if the rack and pinion adjustment is of good make, and in good order, it is possible for the operator to acquire a finer touch with it, and this is in itself worth having. Using the instrument as a simple microscope I at once found that the condenser, when duly adjusted in the ordinary way, noticeably increased the defining power of either of the lenses. The tests used to establish this were unstained human blood corpuscles, and the scales of various Lepidoptera. Naturally the advantage was more pronounced when lamplight was used, *i.e.* with diverging rays; but it is with lamplight that a large proportion of amateur work has to be done. We want the light to converge on the object, and at the proper angle. It is perhaps usual when lamplight is employed to parallelise the rays with a bull's-eye; but no one who has tried the bull's-eye and the condenser in comparison with one another can doubt the superiority of the latter. Since a large illuminated field is necessary, I have taken the light from an opal glass rather than from the lamp direct, or used the bull's-eye in conjunction

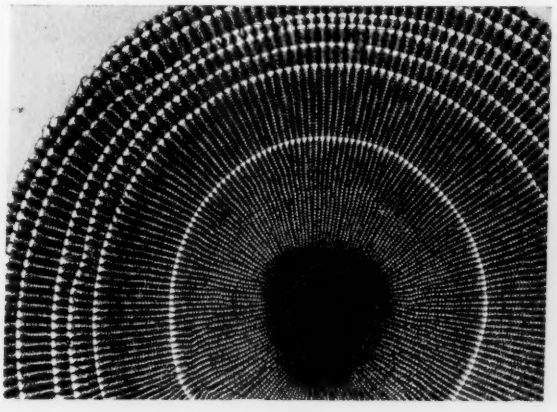


FIGURE 3.
Photo-micrograph of the same Echinus spine which is seen in Figures 1 and 2, taken with an anastigmat (Zeiss) at a short distance.

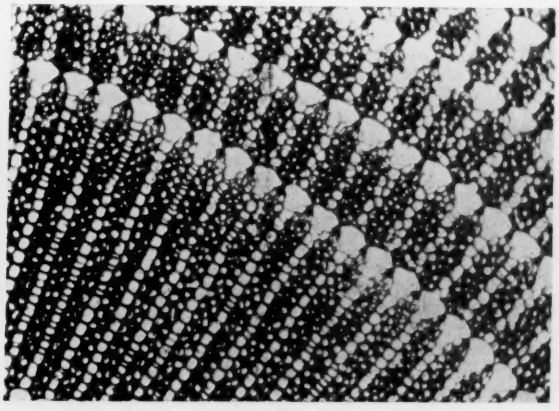


FIGURE 4.
A similar picture taken with the Zeiss anastigmat, the Steinheil being used as an occular.

with the condenser. But it would be better still to have a special low power condenser, giving a sufficiently large image of the radiant, and yet contrived so as to work close up to the object; the Abbe condenser is of course designed primarily for use with high powers, and therefore gives a small image. This is no disadvantage if a tract of sky can be regarded as the radiant; but a special low power arrangement would serve both purposes.

The simple microscope, as described above, serves very well for photographic purposes, and if a vertical camera is not available, a horizontal holder can be extemporised with wood blocks, using wedges of mahogany for levelling, and what I believe are called "window screw bolts" for firm and steady attachment. Another plan, which I have also found quite practical, is to employ one of the special reversing prisms which are made for attaching to oculars; it is only necessary to attach the prism centrally to the magnifier mount. The accompanying photographs of an Echinus spine (section) were taken with the simple microscope described above. Figures 1 and 2 are the work of the ten-diameter Steinheil (by Baker), at two different camera lengths; Figure 3 is the work of the anastigmat (Zeiss), at short distance; while Figure 4 is the combined effect, with the Steinheil as ocular.

E. W. BOWELL.

QUEKETT MICROSCOPICAL CLUB.—May 24th, Mr. W. B. Stokes, Honorary Secretary, exhibited and described a micrometer designed in 1878 by Prof. Burch, of Enfield College. It consists of a small mirror placed above the eyepiece at 45° to the optic axis. In the centre of the mirror, coincident with the axis, is a perforation smaller than the pupil of the eye. A rod at right angles to the axis is attached to the fitting carrying the mirror. Sliding on the rod and at right angles to it is a scale divided into small divisions, usually millimetres. In use, a stage micrometer is placed on the microscope stage. The eye, placed close to the perforation in the mirror, observes the divisions of the stage micrometer superimposed on the sliding scale. For convenience the scale is slid along the rod, which is also divided, until a division of the stage micrometer corresponds with an even or convenient number of divisions of the scale. The stage micrometer is replaced by the object, the real size of which can be at once read off on the scale, the value of the divisions of which, with the particular combination of objective eyepiece and tube-length employed, is known.

Mr. C. Lees Curties, F.R.M.S., for Messrs. Baker, exhibited a number of mounts of Crustacea injurious to wooden piles and piers. Perhaps the specimens of greatest interest were preparations of two rare Isopods, *Leptochelia sairgnii* and *Arcturus* (? sp.)

WATSON'S MICROSCOPE CATALOGUE.—A reference to the twenty-first edition of the catalogue of Messrs. Watson & Sons, of 313, High Holborn, London, which has just been issued, shows the invaluable services which the Microscope renders on every hand, and the necessity of providing Special Microscope Stands for particular subjects that have to be examined.

We find that every Metal Works that is abreast of the times tests its material with Microscopes, of which quite a variety of different models is made, while mining engineers and petrologists have a choice of instruments to which much thought has evidently been given. Visitors to Museums are provided with an instrument that enables them to sharply focus and bring into view twelve successive specimens by rotating a drum, and yet prevents the removal of any portion.

To encourage beginners in microscopy, an inexpensive naturalist's microscope is offered, and commended particularly to agriculturalists, bee-keepers, farmers, gardeners, seedsmen, stock-keepers, dairymen, bakers, fruit-growers and others. Truly if the modern microscope has a place in the work of all these, the necessity for its use must have become universal.

The well-known microscopes for which Messrs. Watson are famous, ranging from the "School" model to the "H" Edinburgh Students and the Van Heurck, are fully detailed and illustrated, while the feature of long-working distance, which has gained for their $\frac{1}{4}$-inch objective so great a popularity, has been extended to the lower powers which now have a working distance equal to about their equivalent focal length. This will be found a great convenience to the amateur.

The catalogue is well arranged and special care has manifestly been taken in its compilation. Difficulty is often experienced in making reference to particular items in such a list. This has been overcome on this occasion by classification into alphabetical order.

The one hundred and sixty eight pages are full of interesting information for the microscopist, and a copy will be sent post free on application to readers of "KNOWLEDGE."

XUM

PHOTOGRAPHY—PURE AND APPLIED.

By CHAPMAN JONES, F.C.S., F.I.C.

DEVELOPMENT.—Although the effects of variations of circumstances and procedure in development seemed to be quite well recognized many years ago, the undue desire that is at present manifest to render the work simply mechanical, and the doubts and troubles which are new at least to new workers, render fresh investigations welcome, whether they deal with old questions or those that have more recently come to the front. Potassium bromide has been used to get increased contrast from the very early days of gelatine plates, and it remains a useful reagent, although it has been condemned, and substitutes have been provided for it over and over again. Messrs. Lumière and Seyewetz (*Brit. Journal* p. 361) have investigated afresh the effect of its addition to the developer, and find that soluble bromides, of which it is the usual representative, do give increased contrast, and that in this they differ from many other restrainers which only increase the time necessary to get sufficient density by development. Other compounds containing bromone only produce the same effect when they are of such a nature that a soluble bromide is produced from them on their addition to the developer. This of course does not prove that *all* other restrainers fail to increase contrast, but it does justify once more the position that potassium bromide continues to occupy.

"Time development," that is the putting of plates into a certain developer for a fixed time, as given in the particular method that the worker believes in, is a practice that at least has the advantage that it renders impossible many faults and accidents from which the novice is liable to suffer. It is universally realised that, other things being equal, the raising of the temperature quickens development. But many, in their endeavour to simplify matters, have gone further than this, and assumed that the same rise of temperature would give the same proportional increment of rate with plates in general. Messrs. Mees and Wratten (*Brit. Journal* p. 376) find that the relationship between time and temperature varies very much with different kinds of plates, and that the time of development necessary to get the same contrast varies greatly, even with different batches of nominally the same plate. They conclude, therefore, that development by time can only be successful when the time and temperature constants are determined for the identical batch of plates being used. Such determinations are very rarely done, and yet "time development" is largely appreciated. This appreciation shows two things. First, what a wide range of variation in negatives is considered allowable by many workers, and, secondly, how many mistakes this mechanical method of working renders impossible.

SHUTTER SPEEDS AND MOVING OBJECTS.—To know whether a given fraction of a second of exposure will be short enough to secure the image of a certain moving object without undue blurring, is a problem that presents itself to all who photograph such subjects. Often the question is shirked, and the exposure given with nothing more to rely on than the hope that it will be quick enough for the subject, and slow enough to give a developable plate. Some, by mere rule of thumb experience, get a general idea as to the conditions that lead to success. Few, if any, consult the elaborate tables that are published stating the average rates of movements of various things, with the time necessary to give a certain (permissible) blurring of the image, because the tables are not available at the time and no memory that is not phenomenal could retain so many details. Besides, the distance of the moving object is an important factor, and this is often not known and may be not ascertainable. There is, however, a method that gets over many of these difficulties and that burdens the memory with only two or three simple figures. A rate of four miles an hour is equal to a movement of seven inches in the tenth of a second. Now seven inches is a distance that we can get a quite sufficiently exact indication of whenever ordinary subjects of this kind are being dealt with, for it is the diameter of the human head. A man walking at four miles an hour moves forward the space occupied by the image of his head on the focussing screen in one-tenth of a second. This gets rid at once of any question of distance and of the focal length of the lens. The image of the head shows the space over which the outlines which are at right angles to the direction of movement will be spread, and without any calculation. If the space is too great it only remains to decide whether it must be reduced, say, to a quarter or a tenth, and to reduce the tenth of a second to the same extent. These figures of course refer to objects moving at right angles to the line of vision, and if the movement is at any less angle than this the rate is proportionately reduced so far as its effect on the image is concerned. In this connection there is a matter that is too often not appreciated, namely, that the parts of an object often move more quickly than the object as a whole. A man walking at four miles an hour will move each leg during one part of its swing at a rate considerably over eight miles an hour. The spokes of a wheel will similarly move at one part of the revolution of the wheel at more than twice the rate of the general movement. Such facts as these tend to largely reduce the differences that there appear to be on inspection of the ordinary tables, between the permissible duration of exposure for the various types of moving objects.

THE ROYAL PHOTOGRAPHIC SOCIETY'S EXHIBITION.—As the New Gallery has been put to other uses, and is not available, the Royal Photographic Society is holding their Annual Exhibition, this year, in the Gallery of the Royal Society of Painters in Water Colours, 5a, Pall Mall East. As this gallery is much smaller than the other, the trade section will be omitted, but arrangements have been made for the Pictorial, Colour, Natural History and Scientific Sections. It is unfortunate that the Exhibition is to be much earlier than usual, opening on August 20th. The 5th and 6th of August are receiving days. Prospectuses and entry forms can be had on application to the Secretary, at the Society's House, 35, Russell Square.

REPRINTS OF PHOTOGRAPHIC CLASSICS.—Mr. Charles W. Gamble, of the Municipal School of Technology, Manchester, is employing the School Press in preparing reprints of important writings on photographic subjects that were published many years ago, and have thus become difficult of access to many students. By the kindness of Mr. Gamble I have received a copy of "No. 1," which is the paper by Professor Vogel in which he announces his discovery of the effect of certain dyes on silver salts, and lays the foundation of the preparation of all orthochromatic, or colour sensitised, plates. These reprints are made especially for the use of the students of the Manchester School, but no doubt Mr. Gamble would send a copy to anyone who is sufficiently interested in the matter to send to him a stamped envelope for the purpose.

A CATALOGUE.—From Messrs. Watson & Sons, we have received the twenty-eighth edition of their Catalogue of cameras, photographic lenses, and so on. The firm in question has added to its f/4·6, f/6·1 and f/9·5 series of "holostigmat" lenses, a wide angle series that includes a field of about 110°. All these lenses are "convertible."

XUM

NOTES.

ASTRONOMY.

By G. F. Chambers, J.P., F.R.A.S.

HALLEY'S COMET.—This historic object has not, so far as England and Europe are concerned, come up to its reputation. Indeed, it was described at the British Astronomical Association, on May 25th, as a "fraud." This expression is by no means extravagant, because, owing to the Comet's position with respect to the Earth and the Sun all this year, it has not been at all easy to get hold of it. As a morning star at the end of April and the beginning of May it was seen by a certain number of people when it was inconveniently near the Sun; and after it got into a better position, at more convenient hours for most people, after May 21st, what with the moonlight and the twilight and the bad weather it could only be seen by fits and starts. The writer, indeed, has only had one good sight of it; and that was on Monday, May 23rd, in a very clear sky. It is very difficult to describe it on that occasion, as seen in a 6-inch refractor. A fairly bright nucleus seemed to have attached to it a stubby "beard" and a very short lenticular tail. From the newspapers it appears that on the evenings of Sunday and Monday, May 22nd and 23rd, thousands of star gazers gathered on elevated positions to get a glimpse of the Comet, low down on the horizon, and met with some amount of success. Two or three days later the Comet had moved to some distance from the Sun, and, as it did not set till about 11 p.m., observers so far had a better chance, but the better chance was discounted by the prevalence of bad and uncertain weather. By telegrams which have come to hand from the Cape and Australia, it seems certain that we shall have to depend upon observers in those parts of the world for systematic, prolonged, and connected observations of the Comet. Telegrams from America report that for a short time, at about the time that the Comet was passing round the Sun (May 18th), it had a tail more than one hundred degrees long! It may be added that the Comet is now moving rapidly Southwards in Declination and forwards in R.A., and will soon be lost to eyes in England.

THE TOTAL SOLAR ECLIPSES OF 1912.—We understand that some proposals for the organised observation of these Eclipses are likely shortly to be made to the British Astronomical Association. It may be remarked, however, that the scientific value of the first Eclipse is not likely to be great, as the totality will only last three seconds, the eclipse being, for all practical purposes, only a good annular one. Nevertheless, as the Totality occurs in a locality so accessible to England as Portugal and the North of Spain, whilst the line of annular phase runs through France, it is likely that the Eclipse, for what it is worth, will attract a goodly number of sightseers.

BOTANY.

By Professor F. Cavers, D.Sc.

POLLINATION OF THE SPOTTED ORCHIS.—It has generally been supposed that the common Spotted Orchid (*Orchis maculata*) is cross-fertilised chiefly by flies, though Darwin, in his book on the fertilisation of Orchids, states that the pollinia of this species have been found attached to bees, and even to beetles, which had visited the flowers. Professor Meldola and Mr. Stewart (*Entomologist*, vol. 43) have recently shown that moths (*Cucullia umbratica* and *Plusia festucae*) also visit the flowers and bring about cross-fertilisation. It is much to be desired that collectors of moths and butterflies should make and record observations of this kind; in many cases, apart from Orchids, the pollen-grains of different flowers show distinctive characters by which they may be identified when found adhering to the bodies of insects.

MENDELIAN WORK ON ELM SEEDLINGS.—At a recent meeting of the Linnean Society, Mr. A. Henry read an interesting paper on hybrid Elms and other hybrid trees. There are only two species of Elm in Britain, *Ulmus montana* and *U. glabra*, both known as "Wych Elm." Among the numerous varieties the most remarkable is the "English Elm," styled *U. campestris*, which is confined to the south of England, and is unknown on the Continent. Some, at any rate, of these "varieties" are, in reality, hybrids between the two species of "Wych Elm." Abundant seeds of the varieties and forms were sown, and the seedlings tabulated and compared; it was found that the characters of the seedlings showed the Mendelian formula of 9:3:3:1. The author then gave details of his experiments with regard to the Black Italian Poplar (a cross between *Populus nigra* and *P. deltoidea*), the Cricket-bat Willow (*Salix alba* × *fragilis*), and the Luccombe Oak (*Quercus cerris* × *suber*), in support of his views (1) that the offspring of a first cross invariably produces a crop of the most diverse character, (2) that when botanists are unable to agree about the forms of a given plant it is due to a mixture of at least two species, (3) that when there is practical unanimity among botanists on the point, as with varieties of ash and beech, there is only one species concerned, and the varieties are due simply to individual peculiarities. Finally, Mr. Henry insisted upon the importance of planting trees of a first cross, on account of their abnormal luxuriance and rapid growth, and their producing timber far more quickly than either parent.

SOUTH AFRICAN SUCCULENT DESERT-PLANTS.—Dr. Marloth recently read before the Royal Society of South Africa, a paper on some new desert plants. One species of "Ice-Plant" (*Mesembryanthemum*) is a shrub bearing at the end of the apparently dead branches a fleshy knob. This knob consists of two closely joined leaves, between which the flower appears; flower and fruit are supplied with food by the sap of the knob until fully developed, when nothing remains of the protecting knob except its skin. Another species of the same genus nurses its flowers and fruits within its own body in an even more effectual manner; it buries itself entirely in the ground, showing only the tips of its few leaves, and as the latter are flat, flush with the soil, and coloured exactly like the gravel, it is practically impossible to detect the plant when not in flower. It was also reported that a Spurge (*Euphorbia elastica*), found in Little Namaqualand, yields a fairly good sort of rubber, so that, with the present rubber "boom," it is possible that even these barren deserts may in the future form the seat of a flourishing industry.

A CURIOUS GRASS GALL.—A remarkable gall on an Indian grass, a species of *Ischaemum*, is described by Mr. Boodle (*Kew Bulletin*, 1910, No. 3). It has the form of a tube about six inches long, resembling a goose quill and arising, with a few scale leaves at its base, from the creeping stem of the grass. The gall is caused by an insect, a species of *Oligotrophus*, and apparently represents a greatly elongated "joint" or internode of the grass shoot.

THE INFLUENCE OF WATER VAPOUR ON POLLEN.—An interesting recent paper by Pfundt (*Jahrb. f. wiss. Bot.*, vol. 47) is devoted to the thesis that the vitality of pollen depends directly upon the humidity of the air. The author shows that in moisture-loving plants, like Alder and Marestail, the pollen remains alive quite as long in saturated as in dry air, but that for most plants the optimum duration of the pollen takes place in a dry atmosphere; in several cases the pollen-grains lived longest in air thoroughly dried in a sulphuric acid desiccator. The vitality of the pollen of land-plants is injuriously influenced by changes in the humidity of the air; and in most cases pollen quickly perishes when moistened and then allowed to dry, death supervening more rapidly the longer the period of wetting has been. Some of the results of Pfundt's experiments are of considerable ecological interest; thus he found that the pollen of spring and

XUM

of autumn-flowering plants is remarkably tenacious of life, but slightly sensitive to moisture, and germinates at very low temperatures—even at freezing point. Freshly-gathered pollen germinated readily in very dilute nutritive solutions, but pollen that had been kept for a time would only germinate in a highly concentrated solution.

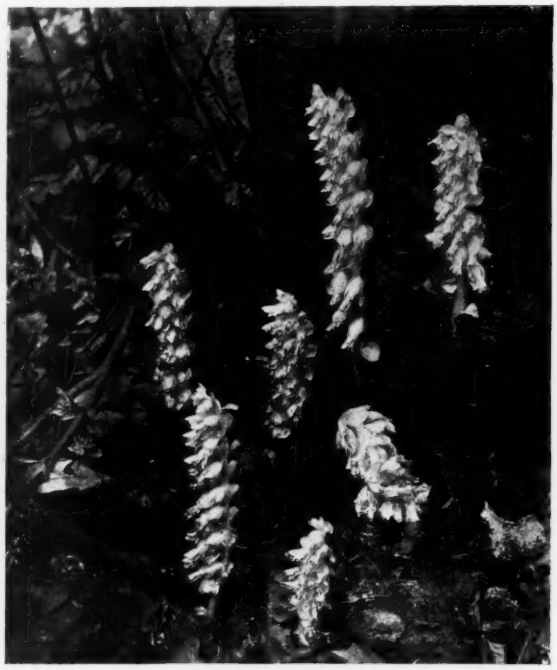
A REMARKABLE ASSOCIATION OF FUNGUS AND ALGA.—In stunted specimens of a toadstool, *Russula fragilis*, Kohl (*Beih. Bot. Centralb.*) found that the lower surface of the cap was always tinged with bright green, this colour being absent from well-developed specimens. Examination showed that the colour was due to a covering of an alga belonging to the genus *Rhaphidium*, and that the presence of this plant had caused the arrest of the development of the gills, which are normally present, and produce the spores of the toadstool. Kohl regards this association as a case of symbiosis between the fungus and the alga.

THE ZONING OF SEAWEEDS ALONG THE COAST.—This subject has been dealt with recently by Miss Baker (*New Phytologist*, 1909-1910) and by Joubin (*Ann. Inst. Oceanogr.*); the former writer has studied only the Brown Algae, the latter covers a much wider field. Miss Baker's general conclusions are that (1) the species of Fucaceae growing in the upper zones have a power of resisting desiccation which is not possessed by those growing lower down, this power decreasing regularly in species growing towards the lower levels; (2) the species which can best resist desiccation grow most slowly, while those that grow most rapidly are the least tolerant of desiccation. The order of zoning observed on the Isle of Wight coast is, starting from the high water line and going downwards, as follows:—*Fucus spiralis (=F. platycarpus)*, *Ascophyllum nodosum*, *Fucus vesiculosus*, *Fucus serratus*.

Prof. Joubin's memoir includes valuable charts showing the distribution of algae and other plants on the shores of Brittany, chiefly in the neighbourhood of Roscoff. He shows how the littoral zones are characterised by species which vary with the nature of the substratum, exposure to the buffeting of waves and to prevailing winds, the presence or absence of fresh water, and so on. The tangles (*Laminaria*) occupy the lowest zone which is ever left uncovered by the tides, and with them grows a narrow zone of *Himanthalia*; the bladder-wracks (species of *Fucus*) grow in the regular tidal zone, alternately exposed and covered; *Pelvetia* forms a zone just above that of *Fucus*, and requires either solid rock or undisturbed shingle; and a lichen (*Lichina pygmaea*) grows just above it again, on sea-washed rocks. The "submarine meadows" of eel-grass (*Zostera*), on muddy sand, do not form a regular zone, but intrude on various zones and replace the other plants when the sea-floor is unstable; *Zostera* requires shelter from the action of the waves, and only in calm water does it grow high enough to be uncovered at ordinary low tides. *Ulva* and *Enteromorpha*, which also require sheltered places, grow in the highest zones wherever there is a sufficient infiltration of fresh water; both genera form triangular patches, with the base exposed seawards and the apex stretching upwards and inwards on the shore, the patches being yellowish if *Enteromorpha* predominates and bluish if *Ulva* is more abundant. The distribution of various other seaweeds is given by Joubin; he shows, for instance, that *Cystoseira* does not, as formerly supposed, form a zone, but is sporadic in its occurrence.

Miss Baker's two papers are of special interest on account of her experiments, undertaken with a view to explaining the *causes* of the zoning of the four species of brown seaweeds which she has studied.

THE EMBRYO OF ENCEPHALARTOS.—The discovery of motile male cells in the Cycads and in the Maiden-hair Tree (*Ginkgo*), reinforced by the still more remarkable proof that in the Coal Period there existed a group of plants (the Cycadofilices or Pteridosperms) which were fern-like in foliage and yet bore seeds, lends great interest to every detail in the life histories of these primitive Flowering Plants. Saxton (*Bot. Gaz.*, 1910) has recently described the later stages in the embryology of the Cycad genus *Encephalartos* ("Kaffir bread"). His results fill in some of the gaps that still remain in our knowledge of this interesting group. The young embryo consists of a uniform mass of cells, but soon differentiates at the free end an actively-growing region, which produces the organs of the embryo itself, from the thick suspensor, which pushes the embryo down into the nutritive tissue (endosperm). In one case the suspensor was observed to have branched, two nearly equal embryos being formed. Two cotyledons or seed-leaves are formed, and these become fused together at their tips; *Encephalartos* closely resembles *Ginkgo*—which is not a Cycad—in the development of the embryo, but up to the present the complete development has not been traced in any of the Cycads.



Toothwort, Parasitic on Hazel.

THE TOOTHWORT.—The accompanying illustration (from a photograph by Mr. H. Gunnery, The Laboratory, Acomb, York) gives an excellent picture of the habitat of the Toothwort (*Lathraea squamaria*), here parasitic on the roots of a hazel, though it also occurs on the roots of beech. A few weeks ago I saw another species (*L. purpurea* or *L. clandestina*) with dark reddish flowers, growing on the roots of a willow in the County Council Gardens at Chelmsford, but it is probably not a native British plant. The underground organs of the Toothwort are of great interest, the creeping rhizome bearing, in addition to the parasitic roots which penetrate the roots of the host-plant, four rows of curious leaves. In each of these fleshy triangular leaves there is a central cavity with smaller cavities leading out of it laterally and ending in chambers whose walls are lined by small glands. It has been suggested by various writers that these leaves act as insect-catching traps, the glands serving to digest and absorb the captured insects. True, small insects and other animals are sometimes found in these leaves, but experiments show that the real function of the leaves is probably the excretion of water by means of the glands. Since the Toothwort has no leaves above ground, except the small scales on the flowering shoots, it cannot get rid of excess water in the ordinary way by the transpiration of water-vapour, and it seems very likely that the gland-lined hollow leaves serve for the excretion of water in the liquid form, just as do the water-glands on the ordinary leaves of various plants.

By GEORGE MASSEE, F.L.S.

THE MESOZOIC FLORA OF NORTH CAROLINA.—Dr. E. W. Berry gives an account of his investigations on the fossil flora of North Carolina in *Bull. Torrey Botany Club.* The fossils are all contained in the Black Creek formation, and are of Mid-Cretaceous age, *i.e.*, somewhere in the lower half of the Upper Cretaceous. Continued exploration by the author and a friend, Dr. L. W. Stephenson, has increased the number of localities where Cretaceous plants have been found, from four to twenty-five, all of which were unknown before 1907. In a previous contribution, reference was made to the striking absence of the Gymnospermae, only one *Sequoia* being sparingly represented. At present fifteen Gymnosperms are known to occur, two members of the order Cycadales and thirteen of the order Pinales. Taxaceae has one or more species; Auracarieae, six species; Taxedicae, four; Cupresseae, one; and Abieteae, one. Four species of *Salix* and two Lauraceous plants are also included. *Cephalotaxospermium* is a new genus founded on fruits, consisting of an outer fleshy layer and an inner bony layer, as in the Cycadales and Ginkgoales. These are considered as evidently the drupaceous fruits of some Cretaceous member of the Taxaceae, which finds its closest homology in the recent flora in the fruits of *Cephalotaxus* and certain species of *Podocarpus*. It is pointed out, in dealing with other plants than Gymnosperms, that a remarkable feature in connection with the North Carolina fossils is, that all the figures on an accompanying plate, except two, are made from sun-prints of the actual leaves carefully washed out of the Cretaceous clays, and subsequently mounted in balsam between glass. The epidermis is preserved in some instances, and the stomata will be described in detail later. They are few and scattered and are confined to one surface, and are altogether absent from the broad leaf-bases. The figures on the plate referred to represent the leaves of a plant called "*Pistia Nordenskioldi* (Heer) Berry, comb. nov."

ANATOMICAL CHARACTERS IN THE EVOLUTION OF PINUS.—Mr. T. W. Bailey has recently investigated the morphological features bearing on the evolution of the genus *Pinus*. Details are given in the current number of the *American Naturalist*. *Pinus* is considered as the oldest genus of conifers and the most important and interesting, whether considered from the botanical, economic or arboricultural standpoint. It is generally considered that flourishing genera are modern, since they show an obvious adaptation to existing conditions of environment; it has been assumed that *Pinus* is of comparatively recent origin, and illustrates the latest phase of coniferous development. Recent investigations, however, have shown the occurrence of *Pinus* in the American Cretaceous period, and that in the lower levels of that epoch, species of pines were apparently much more numerous than they are at the present day. It is apparent that so ancient a genus as *Pinus*, with numerous modern descendants, should prove a very favourable subject for evolutionary investigation. It is considered that anatomical characters which are "notoriously more constant than any others found in the higher plants," have had time to become considerably diversified on account of the long geological range of *Pinus*. Following along these lines, utilising characters mostly derived from the well-known peculiar pits, and so on, characteristic of coniferous wood, the author considers that the large lateral pits of the rays in modern species of *Pinus*, have taken their origin for the most part by the fusion of small pits with distinct circular borders, characteristic of earlier types.

The hard and soft pines with very large lateral ray pits are the most highly developed living pines, represented in North America by *Pinus resinosa*, and in Europe by *Pinus silvestris*, the Scots' pine.

STRUCTURE AND PHYLOGENY OF THE FLOWER OF GRASSES.—Dr. Schuster gives an account of his investigations on these subjects in *Flora*. The conclusions arrived at were the outcome of numerous dissections and microtome sections made on various species of grasses included in twenty-five genera.

Phylogenetically the grasses are considered to have descended from lily-like plants, possessing six perianth lobes in two whorls or circles of three lobes each, six stamens and a pistil composed of three carpels. *Streptochaeta* is considered as the most primitive of existing genera of grasses. In this genus there are three stigmas, six stamens, three inner organs, corresponding to the inner perianth whorl in liliaceous plants, and two outer organs corresponding to the two posterior segments of the outer perianth in lilies; these are located collectively in the axil of the flowering glume. Schuster differs from Haeckel in considering the palea to be formed by the coalition of the two posterior segments of the outer perianth whorl of the primitive type. In primitive forms, as bamboos, six stamens are present, but in most grasses only three stamens are present; less frequently four or five of the stamens are suppressed. The splitting up of the original six stamens is considered to account for the presence of numerous stamens in certain genera, as *Pariana*, and so on. The pistil consists of three carpels, but in most instances the anterior carpel does not bear a style, and hence is abortive.

CHEMISTRY.

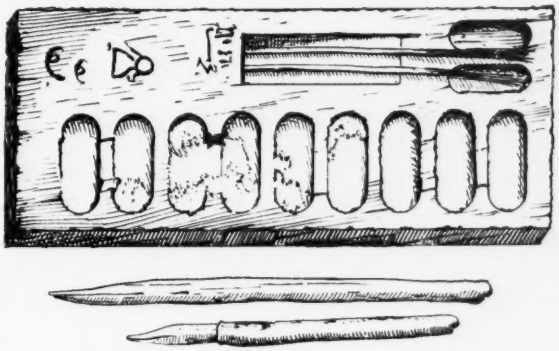
By C. AINSWORTH MITCHELL, B.A. (Oxon.), F.I.C.

CARBON IN WRITING INK.—In a recent law case one of the witnesses stated that he had written certain documents with a mixture of Indian ink and ordinary blue-black ink, in order to give the appearance of age to the writing. Such a statement as this is, of course, open to chemical proof, for it is not a difficult matter to determine whether or no the pigment of a given writing contains Indian ink or other preparation of carbon.

The principle upon which such differentiation is based is that the pigment of ordinary writing fluids is a tannate of iron, mixed with what is commonly termed "provisional colouring matter," to give colour to the writing pending the oxidation of the iron tannate into an insoluble black compound. Both the iron tannate and the provisional colouring matter, which is usually indigo or an aniline dye stuff, may be readily bleached by the application of reägents, such as bromine or oxalic acid, whereas a carbon ink will resist such treatment.

Experiments made by the writer have shown that, with the aid of the microscope, the small granules of carbon may readily be distinguished scattered over the surface of the fibres of the paper after the colouring matter of the other ink has been eliminated.

In early times only carbon inks were used, and it is difficult to decide at what period the transition to iron-gall inks took place. Carbon preparations, probably consisting of lamp-black and glue, were used in ancient Egypt for writing on the papyri; and the various writing materials, dating back to 1500 B.C., to be seen in the Egyptian department of the British Museum, show that the pigment needed grinding up in the same way as the modern Indian or Chinese ink.



Ancient Egyptian palette, brushes and pens.

XUM

In 1821 Sir Humphrey Davy examined papyri from Herculaneum and found no trace of iron oxide in the vestiges of writing left upon them. In his paper upon the subject read before the Royal Institution, he remarks "From these circumstances and from the omission of any mention of such a substance by Pliny, it would seem that the Romans, up to his period, never used the ink of galls and iron for writing, and it is very probable that the adoption of this ink and the use of parchment took place at the same time."

The earliest MSS. on vellum examined by Blagden (1787) dated from the ninth to the fifteenth century, and in these no trace of a carbon pigment could be found. They were all written with iron-gall inks.

Although a carbon ink is more permanent than any iron-gall ink can be, the reason for the change from one to the other is obvious; for the carbon ink had no penetrating power, but could be sponged off the surface of the vellum, whereas the iron ink bit deeply into the fibres and resisted the action of air or light.

For all practical purposes, therefore, a well-made iron-gall ink may be regarded as permanent; and, in fact, a German Statute prescribes that all important official documents must be written in such ink.

A NEW SULPHIDE OF CARBON.—It has been found by Sir J. Dewar and Mr. H. O. Jones (*Pro. Roy. Soc.*, 1910, A 83, 526), that when a silent electric discharge is passed through a rapid current of carbon bisulphide vapour at a pressure of about 1 *mm.*, partial decomposition occurs, with the liberation of sulphur and formation of a new sulphide of carbon, probably the mono-sulphide. This compound is volatile at the ordinary temperature, but may be condensed at the temperature of liquid air; and at a somewhat higher temperature undergoes polymerisation with almost explosive violence to form a brown solid substance. The gaseous form of the new sulphide soon changes at the ordinary temperature, yielding a polymeric compound.

BACTERIAL CORROSION OF IRON.—It is well known that iron pipes imbedded in the soil speedily undergo corrosion, unless protected by galvanising or a coating of tar. This corrosion is shown by Mr. R. H. Gaines, in the *Journal of Industrial and Engineering Chemistry* (1910, 2, 128) to be partially due to the action of bacteria, certain species of which (*e.g. Crenothix, Cladothrix* and *Heptothrix)* are particularly active in this respect. These attack the iron directly by the excretion of an acid product which gradually dissolves the metal, forming a series of pits. In other cases the bacterial action is indirect, and is due to the products excreted by the bacteria rendering the soil acid. Sulphur compounds eliminated by bacteria and produced by their action upon compounds, such as sulphates, in the soil, may also play a part in the corrosive process. Thus, the methane gas liberated by anaërobic bacteria when attacking cellulose, decomposes calcium sulphate in the soil, with the formation of sulphuretted hydrogen gas, which in turn corrodes the iron. As a remedy, it is suggested that the soil in the vicinity of iron pipes should be drained in such a way as to carry off the acid bacterial products rapidly, or, where this cannot be done, that the metal should be surrounded by a layer of slaked lime, which will neutralise the acidity of these products.

GEOLOGY.

THE ORIGIN OF THE VAAL RIVER DIAMONDS.—An interesting series of observations bearing on the origin of the Vaal River diamonds is recorded in Vol. XII of the Transactions of the Geological Society of South Africa, by Mr. H. S. Harger. The parent rock of the gems which are found in the gravels flanking the Vaal River for a distance of two-hundred and fifty miles, has long been sought after on account of the excellence of the stones. Whilst examining the gravels, Mr. Harger found that the so-called high-level gravels are really disintegrated conglomerates belonging to the Dwyka formation, into which they pass. He succeeded in tracing the "bantam" pebbles, which prospectors take as indicators of the presence of diamonds, into the Dwyka "tillite," and found that diggers were finding diamonds in the Dwyka conglomerate. Incidentally he shows that the "bantams" consist mainly of spessartine garnet, which has a specific gravity approaching that of diamond, and thus these pebbles come to be concentrated in the alluvial gravels along with diamonds. The Dwyka "tillite," or boulder-clay, together with the associated conglomerates, which are generally taken to be ancient fluvio-glacial gravels, rest in this district on the amygdaloidal lavas of the Ventersdorp system, and contain a large proportion of boulders derived from that formation. Mr. Harger succeeded in obtaining two small pebbles, each of which contained a diamond. On petrological examination these pebbles proved to be amygdaloidal andesitic rocks, quite comparable with the Ventersdorp "amygdaloids." It is noteworthy that the diamonds do not begin to appear in the alluvium of the Vaal River until it begins to flow over the outcrop of the Ventersdorp amygdaloid.

These important discoveries show that a rock of "intermediate" composition may be the parent rock of the diamond. Until the discovery of diamonds in a dolerite in Australia, ultra-basic rocks were alone thought to play this rôle. Moreover, we are carried back to rocks more ancient than the kimberlite, which was until recently looked upon as the only original diamond bearer of South Africa.

GEOLOGICAL SURVEY PHOTOGRAPHS.—The Geological Survey of England have just issued a Catalogue of Photographs of Geological Subjects, mainly from Cornwall, Devon, Pembroke and Cardigan, with a few from the northern Midlands, numbering 800 in all. Prints from the original negatives may be seen in the Library at 28, Jermyn Street, and copies of negatives, prints, lantern-slides or bromide-enlargements may be obtained of any of these at a fixed tariff, on application being made there. The prices are not quoted, but we understand that the rates are very low. A catalogue of Scottish Photographs is promised.

NEOCOMIAN BEDS IN THE NORTH OF SCOTLAND.—An interesting discovery has been made by Mr. David Tait, who has obtained fossils of Lower Cretaceous age in beds of soft yellow sand at Leavad, in Caithness. The fossils include species belonging to the genera *Craspedites, Desmoceras, Hamites, and Crioceras*, and have a Neocomian facies. The deposit is situated twelve miles west-south-west of Wick, and lies near the southern margin of the great plain of Caithness. The discovery may have important results from a physiographical point of view, but it is not quite certain that the deposit is in place. Possibly it is a huge erratic transported from the Moray Firth district, where, however, Neocomian beds are not known. We understand that a grant has been obtained to enable a bore to be put down to find out whether the fossiliferous bed rests on the Old Red Sandstone or is enclosed in boulder-clay. Whatever be the outcome of this investigation, a Neocomian fauna from this northern locality should prove to be of great interest, in view of the work that has already been done on the distribution of climatic zones in Neocomian times.

THE JURASSIC ROCKS OF DORSET.—In a remarkable paper on the Lower Jurassic rocks of the Dorset Coast, published in the Quarterly Journal of the Geological Society, Mr. S. S. Buckman classifies these beds by the zonal system in great detail and arrives at some curious, and, at the same time important results. Thus the Upper Lias part of the Junction Bed, near Chideock, is a very condensed imperfect epitome, in twenty inches, of about one-hundred and eighty feet of strata on the Yorkshire coast, and of very much more when allowing for gaps; whilst a two-inch layer lying between the *bifrons* and *striatulus* bands in the same bed represents some two hundred and fifty feet of deposit in the Cotteswolds. Hence he concludes that two feet of Junction Bed was formed while a thickness of some five hundred and fifty feet was being deposited elsewhere. The strata described are arranged among thirty-six zonal (hemeral) divisions, whilst the total for the whole of the Jurassic is estimated at eighty-five. Of these the beds of the Inferior Oölite cover about twenty-two, or about a quarter of the total time occupied in the deposition of

the Jurassic system. It is difficult to believe that the twenty feet or so of Inferior Oölite limestone, which is all there is to represent this stage in some localities, represents an interval of time equal to a quarter of the whole Jurassic Period, during which thousands of feet of strata were laid down. The author considers that the difficulty lies in not allowing sufficiently for the gaps, and would account for the extraordinary abundance of species in these attenuated strata by reason of their slow accumulation. In fact he suggests that the Inferior Oölite in Dorset might be defined as a series of gaps united by thin bands of deposit, just as a schoolboy describes a net to be a series of holes strung together.

METEOROLOGY.

BY JOHN A. CURTIS, F.R.MET.SOC.

THE WEATHER OF MAY.—For the first half of May the weather was cold and unsettled. It then improved, becoming warmer and gradually more settled. The last days, however, were again cold and wet. *Temperature* during the first fortnight was below the average in all districts of the British Isles, the defect exceeding 4° in several places. In the first week the highest reading reported was only 66°, in Scotland N. and England N.E.; in the second week it rose to 71° in the Midland Counties, but in neither of these weeks did the temperature at Guernsey exceed 57°. During the third week much higher readings were reported, up to 83° at Hillington on the 20th, and to 80° at Fulbeck and Lincoln. Jersey reached 69° on the 16th. The week ended May 28th, was also warm, though nothing above 77° was recorded. This temperature was, however, reached in many places. The coldest days of the month were from the 8th to the 11th, and at West Linton, to the S.W. of Edinburgh, the minimum in the screen fell as low as 22° on the 9th. Frost was reported this week in all districts except the English Channel. *Rainfall* during the first week was in excess; in the second week it was normal; in the third week it was again in excess, except in Scotland and in Ireland N.; while in the fourth week it was in defect, both as to amount and wet days, in all districts. *Thunderstorms* were frequent and general, and, in the early part of the month, were in places accompanied by showers of hail and sleet. *Sunshine* on the whole was about the average, the sunniest week being that ended May 14th, when at Yarmouth the percentage of sunshine observed compared with the possible amount, was as high as 77 per cent, while at Skegness it was 75 per cent. Strong winds were frequently observed, and these occasionally reached gale force, but no violent gales were reported. In the third and fourth weeks the winds as a rule were light. At the Royal Observatory, Greenwich, the temperature in the shade varied from 30·°4 on the 10th, to 78·°0 on the 28th, the average being 54·°3 as compared with an average for 65 years of 53·°1. The 10th was the only day on which the reading in the screen was below freezing point, but on the grass, frost occurred on eight nights, the lowest reported being 25·°1, also on the 10th. The maximum in the sun, as registered by a thermometer with blackened bulb, exposed *in vacuo*, was 137·°1 on the 20th.

Rain fell on twenty days, the total measurement being 2·26 inches, or 0·26 inch above the average for fifty years. The heaviest fall in a day was 0·48 inch on the 18th.

Bright Sunshine was recorded at Greenwich on each day during the month except the 2nd. The total amount was 219·4 hours, the maximum in a day being 14·1 hours on the 23rd. On the 20th, the day of the funeral of King Edward VII, the registered amount of sunshine was 13·3 hours.

HALLEY'S COMET.—Special interest was taken in many places in meteorological observations during the passage of the Earth through the tail of Halley's Comet on May 19th—20th. So far, however, nothing has been reported either in Meteorology or in Magnetism, which cannot be accounted for without reference to planetary influence.

Special arrangements were made for balloon and kite ascents at many different places both at home and abroad during this period, and at some stations on the Continent efforts were to be made to secure samples of air at great heights. The results have not as yet been issued, but when prepared they are sure to be of considerable interest.

SYNOPTIC REPRESENTATION OF ATMOSPHERIC MOTIONS.—On May 27th Professor Victor Bjerknes, of the University of Christiania, lectured at University College, London, upon the "Synoptic Representation of Atmospheric Motions." The lecture was arranged for by Dr. W. N. Shaw, F.R.S., the Reader in Meteorology at the University of London, and a large number of persons accepted the invitation to be present. Prof. Bjerknes elaborated his method of representing synoptically the meteorological element of vector nature, air-velocity, and showed by maps how it might be practically applied. He urged also the desirability of the publication by the various Meteorological Institutes of strictly simultaneous hourly values observed at a network of well chosen stations during sufficiently long periods of time, and explained how such observations would open a vast field for dynamical research, especially if organised with the ascents in the free atmosphere.

THE ROYAL METEOROLOGICAL SOCIETY.—On May 25th, an interesting paper was read by Mr. R. Corless, B.A., upon the Rate of Rainfall at Kew in 1908. The paper was an answer to the inquiry of Engineers who have long been asking for information as to the rate of rainfall, as well as its total amount. The record of the ordinary Beckley gauge was taken, and by means of Dr. Erskine-Murray's differentiator the trace was translated into a curve showing the rate of the fall moment by moment. Curves so obtained are not free from error, and under certain conditions these errors may be large. It remains to be seen as to how far the method will give Engineers the information they require, but if their answer is satisfactory there would seem to be no insuperable difficulty to designing a rain gauge that should record directly the rate of fall instead of the amounts in stated intervals, as at present.

PHYSICS.

ELECTRIC DISCHARGES FROM RADIUM.—One of the disappointments which awaits the lay person who examines radium for the first time is the discovery that its radiations are not visible, though, of course, they can be made visible through their effects in the spinthariscope, where the products of its disintegration impinge against a suitable screen and cause flashes of light. But M. Debierne, in connection with some work on the collection of radium, has recently observed spontaneous electric discharges visible in daylight, in the little tubes containing the emanation. The sparks are often as frequent as one a minute, and are sometimes several millimetres in length. They are usually produced in the interior of the glass of the capillary tube, which then becomes furrowed with little cracks resulting from their passage. Sometimes the electric discharge is produced across the emanation itself, which is rather brightly illuminated. These discharges are only produced with certain kinds of glass. A glass which showed them most was one containing lead. The glass became violet under the action of the emanation. Other glass, containing a large proportion of lead, did not show the phenomenon. The discharges may be attributed to the accumulation in the glass of the α and β rays, when the glass is a sufficiently good insulator.

THE TESTING OF EXPLOSIVES.—For the last twenty years the Royal Military Experimental Bureau of Berlin has been occupied in the examination of explosives for military purposes. The degree of sensitiveness to shock is a point of great importance and significance when the questions of using, storing and transporting explosives have to be considered. Hence the testing of this sensitiveness has always occupied a great deal of the attention of the Bureau, and a paper by Dr. H. Kast, of Berlin, gives a number of results which have arisen from the testing of explosives by the

XUM

drop-hammer method. He first describes the conditions of the drop-hammer test, which is so arranged that the contrivance always complies with the conditions (1) That the surface to be struck is always a definite and invariable area, and (2) The explosive must be so arranged that it cannot spread out sideways. There are a number of other conditions but these are the major ones. It is more interesting to examine some of the results as to sensitiveness that have been reached. For example guhr-dynamite and gelatine-dynamite are more sensitive than blasting gelatine. Powdered explosives are more sensitive to shock than grained explosives: colloidal gun cotton powders are less sensitive than gun cotton: chlorate explosives enveloped in soft plastic substances are less sensitive than those prepared without such envelopes; nitroglycerine is less sensitive than dynamite. Another point arises with regard to the friction of explosives. Thus the chlorate explosives are more sensitive than dynamite to friction, but they are less easy to explode by percussion.

PHYSICS AND METAPHYSICS. — In a suggestive address on "The Debt of Physics to Metaphysics," Professor Henry Crew has pointed out that what is perhaps the central idea of modern dynamics—the idea of force, is a pure concept of the intellect. From many points of view it is one of the most complex and puzzling of physical quantities. Sir Oliver Lodge says "We are chiefly familiar from our youth up with two apparently simple things, *motion* and *force*. We have a direct sense for both of these things. We do not understand them in any deep way, probably do not understand them at all, but we are accustomed to them. Motion and force are our primary objects of experience and consciousness: and, in terms of them, all other less familiar occurrences may be stated and grasped. "This is at any rate less decisive than the standard definition of force in text books of dynamics:—"Force is defined as a pull or a push, something that causes or tends to cause either motion or a change in the velocity or direction of motion." But we do not actually possess any direct muscular sense of force, in the physical meaning of the word, as distinguished from the muscular tension with which we all are familiar. What we really are familiar with is the *effects* of force. Galileo, three centuries ago, knew better, and in his "Dialogues" he introduces force as a synonym for any of those unknown influences which produce acceleration. He confesses himself ignorant of the nature of the causes; he only surveys the effects. Newton followed him in time; and to-day all definitions of force come back to that of these two great physicists, namely the "rate of change of momentum as the one perfectly correct, competent and complete description of force."

ZOOLOGY.

By Professor J. Arthur Thomson, M.A.

CHANGE OF COLOUR IN A RATEL.—We associate old age with grey hairs, but Dr. F. D. Welch observes that in a ratel (*Mellivora ratel*) which has been living in the Zoological Gardens for about twenty years, the large dorsal grey patch has recently begun to turn black. Now, indeed, all the back is black with just a sprinkling of grey hairs.

A TREE-FROG'S REMARKABLE NEST.—Dr. W. E. Agar tells us that a tree-frog (*Phyllomedusa sauvagii*) makes a nest among the leaves of bushes overhanging the pools into which the tadpoles drop when they are hatched. A number of leaves are held together by a deposit of empty gelatinous egg-capsules, such as we sometimes see in frog-spawn. The cavity thus formed is filled up with a mixture of full and empty egg-capsules, and then there is a lid of empty ones at the top again. It seems that the empty capsules not only keep the leaves together till the tadpoles are ready to drop, but they form a protective shield and afford an extra supply of water. Dr. Agar observed that there was least mortality in the more perfect nests, so that the peculiarity of producing empty egg-capsules and the habit of using them would be fixed by Natural Selection.

YOUNG SPIRULA.—Many are familiar with the beautiful internal chambered shell of the small cuttlefish, Spirula. It is occasionally cast up on our shores, as far north as Aberdeen, though the animal lives in much warmer waters. The pleasure of capturing the first young one that has been seen has been enjoyed by His Serene Highness the Prince of Monaco, who got one from a depth of 3,000 metres, to the south-east of the Canary Islands. Dr. L. Joubin reports that it was about 5 mm. in length. The shell had six chambers, forming almost a whorl. There was no hint of the median posterior sucker with which the adult adheres to rocks.

ANTS AND SEEDS.—There is always something new about ants. F. W. Neger, the Professor of Botany at the famous forestry-school (Forst-akademie) at Tharandt, near Dresden, has made an interesting study of the custom of *Messor barbarus*, a common ant (in Dalmatia for instance), which is at once a leaf-cutter and a seed-gatherer. Neger noticed that most of the seeds (of Leguminosae in particular) were allowed to begin to germinate before the ants put them out to dry, and he suggests that this is to burst the seed-coats. But the germination is not allowed to go far enough to ferment the starch into maltose and dextrin. When the seeds are thoroughly dry and dead, they are taken back to the nest and chewed into a dough. This is baked in the sun into minute biscuits, which are stored!

TAILOR-ANTS.—One must confess to a feeling of relief at finding circumstantial confirmation of some of the extraordinary tales that have been told of *Oecophylla smaragdina*, a common ant of hot countries. E. Bugnion vouches for the habit that these creatures have of using their silk-secreting larvae as needle and thread when they are binding leaves together to make a nest. As is well-known, they nest in trees, and sometimes they find it difficult to bring two rather distant leaves close enough together to be sewn. Bugnion confirms the tale that five or six will form a living chain to bridge the gap. The waist of A is gripped in the mandibles of B, who is in turn gripped by C, and so on,—a literally living chain, and a notable gymnastic feat. Many chains may work together for hours on end trying to draw two leaves close to one another.

HABITS OF THE ROBBER CRAB.—Dr. C. W. Andrews has published in the proceedings of the Zoological Society an interesting photograph of the robber-crabs (*Birgus latro*) on Christmas Island. It shows them climbing trees,—a habit often doubted. They simply walk up, clinging by the sharp points of the walking legs, hardly using the large claws at all. They are easily frightened and "scuttle off backwards, propelling themselves with their long anterior legs in a series of ungainly jerks. They seem quite conscious of the comparative defencelessness of the abdomen, which they endeavour to thrust under logs or into holes among the roots of trees." But they never carry any protective covering. At Christmas Island they ate fruits of various kinds (such as sago palm and screw-pine) and carrion of all sorts. True to their name they were a great nuisance, stealing from the camp at night anything that seemed edible—almost anything, indeed, that had been handled, cooking utensils, bottles, geological hammers, and clothes. Dr. Andrews complains that he had a geological hammer practically ruined by having its handle splintered in the powerful claws of one of these creatures.

MITES AND MEN.—There have been many hints lately that mites have a more complicated inter-relation with man and his stock than that which is implied in their being a punishment for lack of cleanliness. It is probable that they have, like ticks, a rôle in the spreading of disease. It may be that even the common follicle mite (*Demodex folliculorum*) may play its part. One of the hints we have alluded to is Dahl's announcement of a new mite, *Tarsonemus hominis*, found by Dr. Saul in two cases in a human tumour. Was it simply a parasite in the tumour, or had it anything to do with causing it? It is well-known that some of the species of *Tarsonemus* cause gall-like cell-proliferation in plants.